REFINER
AND NATURAL GASOLINE MANUFACTURER

FEBRUARY, 1935
Vol. 14, No. 2

A Gulf Publishing Company Publication
EDITED MONTHLY AT HOUSTON, TEXAS

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GEORGE REID
Editor

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SPECIALIZED OIL JOURNALS

Published by

GULF PUBLISHING COMPANY

OFFICE OF PUBLICATION
3301 Buffalo Drive, Houston, Texas

R. L. DUDLEY, *President*
A. L. BURNS, *Gen'l Manager*
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TULSA: 1020 Hunt Building, J. F. Carter, Jr., Manager.

FORT WORTH: 203 W. T. Waggoner Building, H. H. King, Manager.

Single copies 20 cents. Domestic and Foreign subscription price, $1.00 a year. Entered as second class matter June 16, 1923, at the post office at Houston, Texas, under Act of March 3, 1879. Advertising rates on application.

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VOLUME 14, No. 2 FEBRUARY, 1935

REFINER
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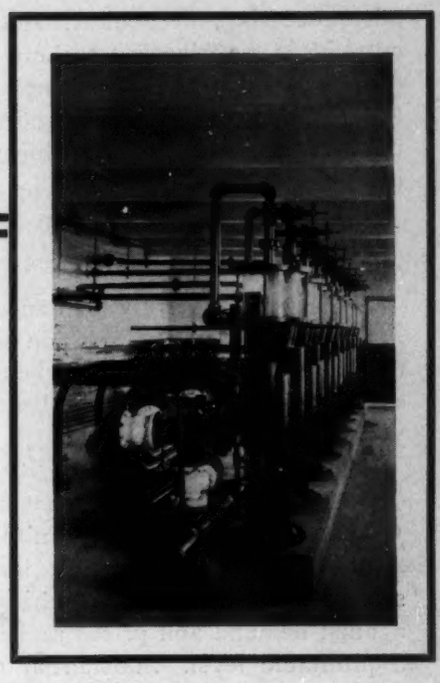
The Look Box



THE REFINER next month starts presentation of an important symposium on Engineering Progress in Petroleum Refining. The symposium consists of a large group of papers prepared by well known authorities in various fields and directly applicable in their context to the technical and practical problems of today. The symposium will be concluded in the April issue.

Engineering Progress

Progress in metallurgy and application of newer metals to petroleum refining processes and equipment will be reported, and with a look to the future. Similar progress in electrical equipment and its application will be presented. Special articles on the corrosion problem, heat resisting alloys, refinery pumps, heat exchangers and condensers and development in pipe and tube products are scheduled.

A newly developed process in the manufacture of asphalt will be discussed in detail as to its operation and results secured. Late development in regard to a scientific process for the removal of hydrogen sulphide from gases will be presented. The trend in development of treating systems and utilization of various chemicals is outlined. Another article discusses trends in design operation of gasoline plants.

In the March issue will begin one of the most valuable series of articles that THE REFINER has ever had the pleasure of presenting to its readers. It deals with the highly important subject of inspection of refinery equipment, tracing the work from the organization of such departments through all phases of its work, and has direct bearing on the proper utilization, functioning, maintenance and replacement of all refinery processes, systems and facilities.

This symposium on Engineering Progress is designed to, and will be of aid in checking up on plant methods to ascertain that latest information and data is employed, to keep abreast of new developments, to keep the work of the organization in line with highest professional standards, and to save time and effort through simplifying the work. Each contributor to this symposium has been selected because of his proven abilities, experiences and reputation in the specific field of the industry, and as a result the material at hand gives positive indication that the symposium will prove to be one of real value.

GUM in gasoline and the automobile engine continues to be a troublesome problem. A. W. Trusty correlates a lot of data on the subject. Practical considerations on the selection of refinery pumps is a subject on which suggestions are always welcome, and L. D. Wyant presents some interesting side-lights. The promised article on asphalt manufacture by Casmite Oil Company which relates of the dignitary in Siam who wished colored asphalt paving materials for his garden

This Issue

walks is presented. W. L. Nelson presents part two of his series of discussions on Laboratory Evaluation of Oil Stocks and Garton and Huntington conclude their series on efficiency of fractionating columns.

Another feature starts in The Look Box dealing with "Ideas" to which readers are invited to contribute short articles dealing with plant methods, processing, mechanical, safety features, short cuts, ideas contributing to better efficiency and economy will be welcome—and paid for. These "Ideas" may come from any department of the plant, laboratory, office, engineering or research department.

THE year 1934 truly was an outstanding one. A favorable statistical position was attained and the industry enters 1935 with better statistical and economical prospects than it has known in many years.

Annual Statistics

During 1934, the upward trend of consumption continued and total demand for United States petroleum reached its highest level since 1930. There was close balancing of supply against demand and prices remained constant at a profitable level. Substantial reductions were made in stocks of both crude oil and refined products and now are at the lowest figure in seven years. Imports were slightly higher than in 1933 but did not reach levels of other years.

With every statistical division greatly improved, and apparently no unusually large field in the immediate offing, the outlook is bright.

SEVERAL bills have been introduced into the Texas Legislature that propose means for curing the wastage of natural gas in the Texas Panhandle, a subject that has become quite important. One bill would require ratable taking of gas by those engaged in the transportation of gas and would establish a fair rate for gas purchased. Another bill would prohibit any concern from engaging in both production and transportation of gas. A third bill is similar to the ratable taking bill. A bill of the latter nature was declared unconstitutional by federal courts two years ago.

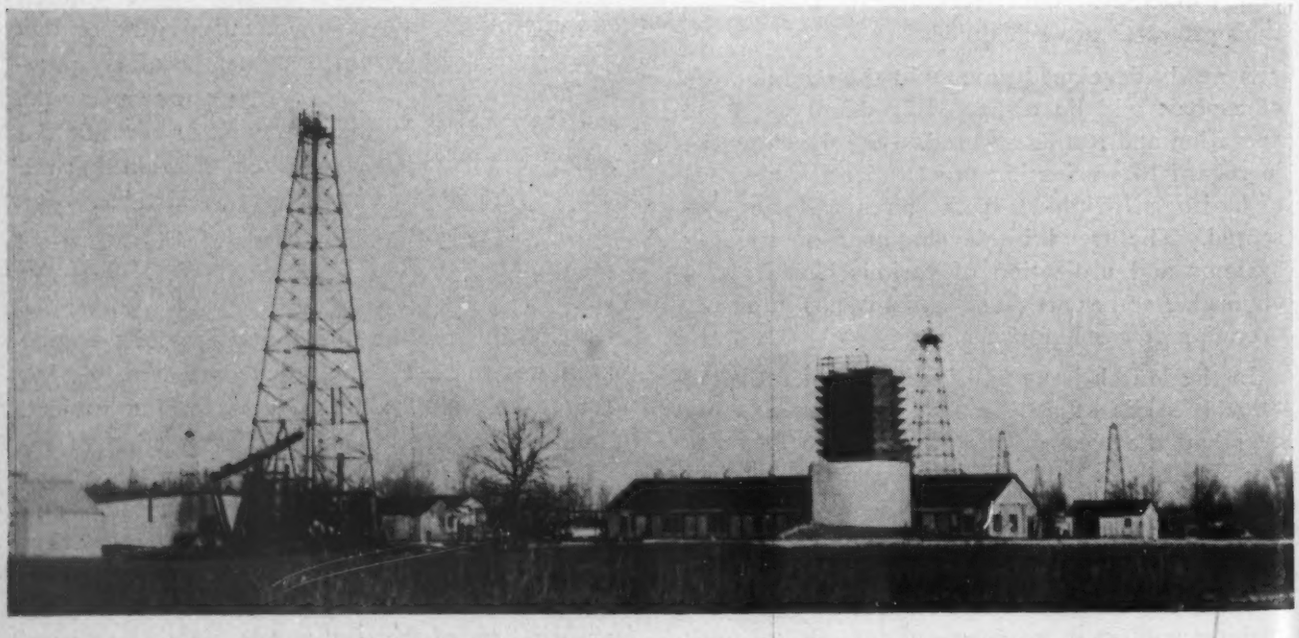
Gas Waste

THE crisis in control, or over production peril, which was expected by some to grow out of the recent ruling by the Supreme Court in the Panama and Amazon cases, failed to materialize. That decision was a signal that promised some in the industry to expect, and prepare for, a flood of oil out of East Texas. But it has failed to come about and normal activity goes on.

But Little Happened

There was, following the decision, some increase in hot oil producing and refining in East Texas, the volume rising to around 25,000 barrels daily, it was estimated, from around 10,000 barrels. No increase was reported, however, in the number of refineries processing hot oil, less than a dozen plants being credited with turning out hot material. Even at the increased level, such hot oil does not constitute cause for great concern.

(Continued on page 37a)



The first casinghead gasoline plant in the Porter, Michigan, field is Apex Gasoline Company's which has just been put in operation

Operating Details, *Clark* Vapor Phase Cracking *Process*

J. C. ALBRIGHT

A UNIT of the Lincoln Clark Vapor Phase Process for cracking petroleum fractions (developed in the laboratories of Lincoln Clark at Pasadena, California) was placed in operation in the plant of Rice Ranch Oil Company at Santa Maria, California, late in 1934. This process differs from others used for cracking in that the heat is applied directly to and mixed in intimate contact with superheated gas-oil vapors, instead of being transmitted to them through steel tubes.

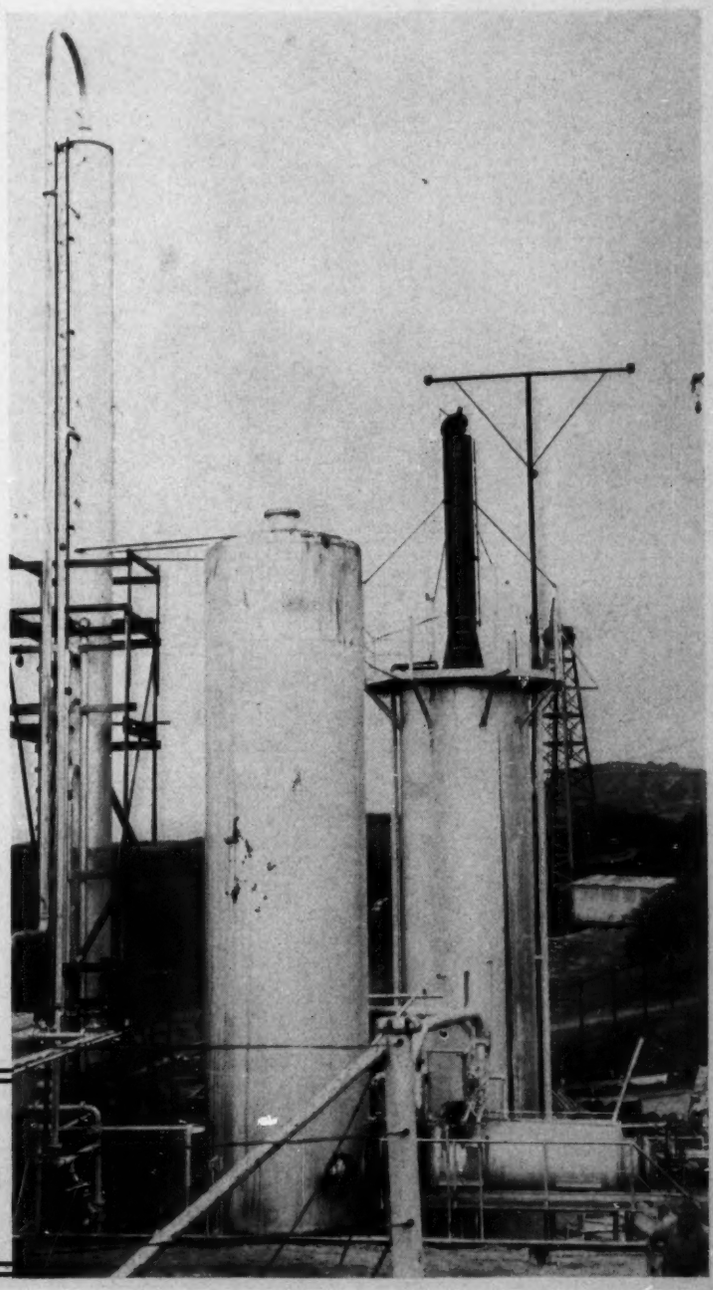
The installation includes both topping and cracking. Clean gas oil is the material used directly in the cracking process, which may be manufactured in the combination unit, or secured from other sources. Two materials are available at this plant, one of which is topped crude and the other a fresh oil produced in the field nearby.

The principal parts of the unit consist of a two-pass heater, or tube still, a combustion chamber (in which the fuel to produce cracking temperatures is burned) a vertical reactor, a vertical rectifier, receivers for residuum and gas oil and the usual set up of exchangers and vapor condensers. Skimming of the virgin crude is accomplished in the rectifier, from which only three cuts are removed; overhead vapors being gasoline, a side cut of gas-oil and the residuum taken from the base.

The method of operating this unit, which may be varied as to the requirements of the company, is that a charging stock of cold crude is pumped to the fractionating, or rectifier column by passing it through gas-oil reflux and residuum coolers to utilize all waste heat where permissible. The charge, heated to 457° F., is introduced to the rectifier above the ninth plate from the base. These nine plates are utilized both as stripping trays and for residuum reduction.

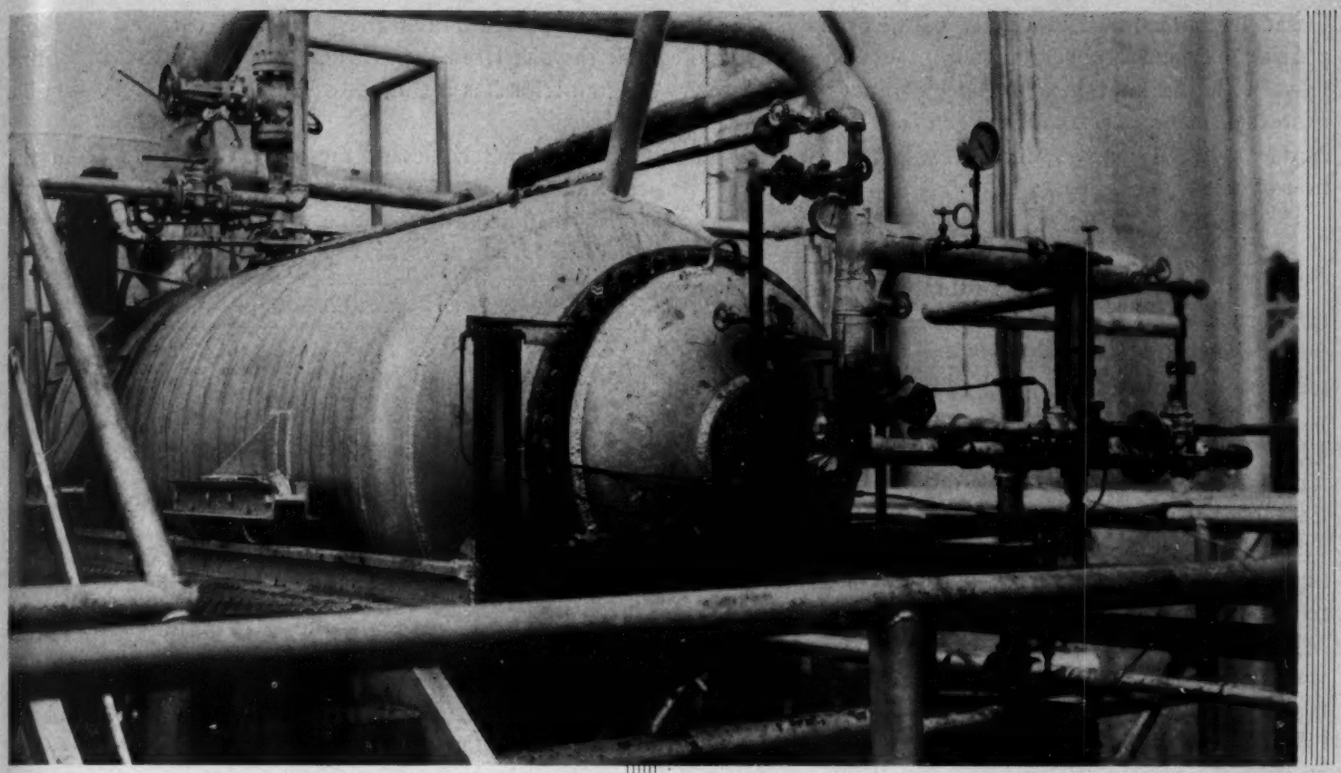
A draw-off pan was placed in the rectifier above the twelfth tray from which a gas-oil is removed which includes all fractions between residuum and gasoline. This gas-oil cut is the raw material which is later charged to the cracking part of the unit. It is received in a large horizontal accumulator drum from which a portion is pumped back to the column, entering above the nineteenth tray, to control the ascending vapors. The remainder is passed by the same pump, at a temperature of 496° F., directly to the heater or tube still.

This heater contains two separate banks of tubes, the first of which is used as a vaporizing section, and the



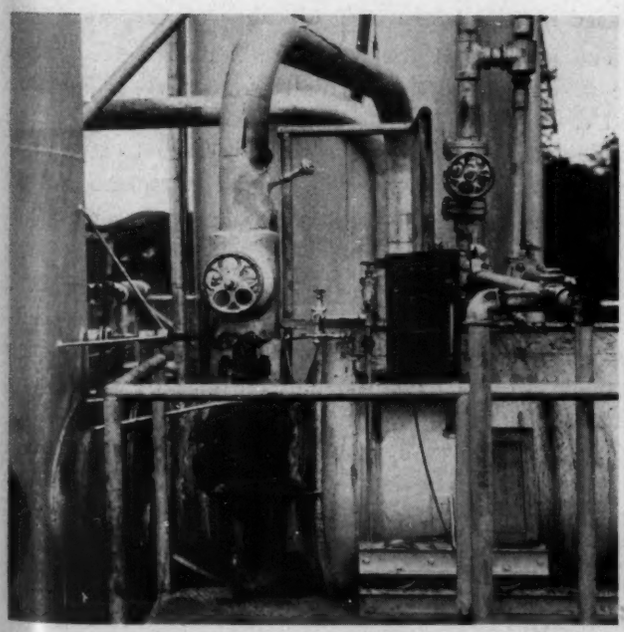
Clark Cracking Unit, Rice Ranch Oil Company's Plant at Santa Maria, California

CLARK VAPOR PHASE PROCESS
FLOW SHEET
OIL VAPORIZER AND SUPERHEATER
FLASH DRUM
COMBUSTION CHAMBER AIR AND GAS COMPRESSORS
REACTOR
RECTIFIER
RECYCLING RECEIVER
GAS OIL RECEIVER
RESIDUUM
CHARGE
COOLER
CONDENSER
ACCUMULATOR
PRODUCT
ABSORBER
EXCHANGERS
STILL
RECEIVER
ABSORPTION PLANT



Above: Front end of combustion chamber in Clark vapor-phase cracking unit

Below: Method of connecting combustion chamber to reaction chamber and point of introduction of superheated gas oil vapors into the cracking zone. Four-inch overbend entering the neck of the unit carries superheated vapors from coils in the tube still.



second as a vapor super-heater. Between these two banks is a flash drum which acts as a receiver for the unvaporized portion of the gas-oil charge and as a stripper. The unvaporized gas-oil is passed back to the rectifier under the flash drum pressure of 48 pounds, to be reprocessed in that column. Vapors leaving the flash drum re-enter the heater and pass through the second section of tubes where the temperature is raised from 750° F. to 810° F.

The super-heated gas-oil vapors are led through an insulated transfer line from the outlet of the second section of the heater to the heart of the cracking unit. This point is a constricted connection between the combustion chamber and the reactor. The combustion chamber is a horizontal unit designed to produce heat under pressure by burning in it refinery vapor-recovery stripped, or residue gas, pipe line gas or fuel oil. The necessary amount of both the fuel used and the air essential for combustion is pumped into the chamber through a special pre-mixing apparatus under a pressure of 40 pounds, gauge.

A necessary procedure at this point is to properly proportion the fuel and air so as to secure a non-coking flame containing no excess oxygen. The control of the mixture of fuel and air may be maintained through a set of hand operated valves, or proportioning instruments may be used instead. In either case, when the proper mixture and volume of fuel and air have been obtained, no further attention is required, assuming that the pressure on the supply of each remains constant.

Tests are conducted at regular intervals to determine the condition of the gases of combustion by using an

Orsat instrument. The object of this analysis is to provide oxygen-free combustion gases which will not react with the superheated gas oil vapors with which contact is made. If excess oxygen is fed to the burner, contact with the vapors would result in burning a portion of the charge.

TEMPERATURE 1010° F.

The point where the superheated vapors come in contact with the gases of combustion is in a restriction between the combustion chamber and the reactor. The temperature of the gases of combustion at the point where the superheated vapors enter is maintained at 1010°F. The time of intimate contact has been calculated at the point of intimate mixture, as well as the time of soaking, or passage through the reactor, to produce sufficient conversion of the gas oil fraction to high octane gasoline without over cracking and an attendant large gas loss.

The reactor is a large vertical vessel having a dividing wall placed inside from the base to a point near the top. The hot vapors pass through the reactor and are taken from the vessel at a point opposite from that of entry. The reactor is connected directly to the rectifier and the hot vapors in process enter the rectifier near the base and below all stripping and fractionating trays. The heat of this contact is used for skimming the raw charge of fresh crude, and in reducing the bottoms when it is necessary to convert them from fuel oil to a material used in highway construction.

The company has processed both topped crude and fresh oil from their wells in this plant, and conversion data for a topped crude charge follows:

Charging stock, 14.3° A.P.I. topped crude.

	Percent
Cracked gasoline produced, 47.1° A.P.I. Engler distillation showing 90 percent over at 392°F.	23.0
Residuum, 10.3° A.P.I.	70.8
Gas and loss	6.2
	100.0

The gas in this case has a gasoline content of two gallons per 1000 cubic feet, and the bottoms are used in highway construction.

Conversion data when a fresh crude is charged to the plant shows the following:

Charging stock, 21.1° A.P.I. crude.

	Percent
Straight run gasoline content of crude	20.2
Total gasoline produced	43.1
Residuum, 8.3° A.P.I.	48.5
Gas and loss	8.4
	100.0

Bottoms from this charge is also used as road oil, and the gas from the cracked and straight run gasoline accumulator has a content of 2.8 gallons per 1000 cubic feet.

The characteristics of the gas oil obtained from the rectifier and used as a cracking stock is substantially constant under all operating conditions; an Engler distillation of which is as follows:

Gravity	20.2° A.P.I.
IBP	476°F.
10 percent	488°F.
20 percent	500°F.
30 percent	506°F.
40 percent	516°F.
50 percent	534°F.
60 percent	554°F.
70 percent	584°F.
80 percent	618°F.
90 percent	660°F.
98.5 percent	700°F. End point

The gasoline produced from either charging a reduced topped crude or fresh oil from the wells shows a high octane value, and this feature can be controlled by the operation of the plant as a whole. The residuum as bottoms from the rectifier can be processed to practically any specification road oil or fuel oil by recycling a portion of it from the surge tank, or residuum receiver back to the rectifier on the fourth plate.

Overhead vapors from the rectifier are condensed in standard type units and accumulated in a receiving drum, from which a portion is removed and returned to the third tray from the top to control the 90°F. point of the finished product. Uncondensed vapors received in the condensate accumulator are picked up by compressors in a combination gasoline plant and vapor recovery unit and processed in a conventional oil absorption unit to recover the desired fractions not condensed in the usual overhead vapor condensers.

The product of the combination unit is blended in the desired proportions with recovered vapor gasoline and casing-head gasoline to produce the desired grade of finished product. This blend is then treated in a Lachman Zine Chloride vapor-phase treator to control color stability and remove a small amount of gums formed by cracking.

The processing cycles, or length of runs have been limited to 21 days each, not from any operating difficulty or the results of operation, but solely from a desire to inspect the interior of all parts of the various units to determine whether they have been operating properly. Coke as a product of cracking in this unit is absent, none having been deposted in the reactor during any of the operating cycles, and as the procedure is to run the residuum or bottoms to a road manufacturing material, coke is not a desired feature of cracking by this or any other method.

Gum in Gasoline *and the* Automobile Engine

A. W. TRUSTY
Chief Chemist, Louisiana Oil Refining Corporation

CONSIDERABLE work has been done to correlate laboratory gum determinations and actual behavior in engine and storage, but due to the many variables of storage and engine use, and to the different methods of testing for gum, the correlation is not clear cut.

Some engines are more sensitive to gum formation than others; the variables are the temperature of the charge, the design of the manifold system, the degree of vaporization in the manifold system and the temperature of valves and seats. Little work has been done to investigate these variables. Conditions of storage, also affect gum formation. Quiet, undisturbed, full tanks of gasoline, with little variation in temperature to cause breathing, and with low temperatures would form much less gum than a partially filled tank, subjected to warm weather and continued disturbance by pumping into and out of.

The present methods of gum determinations are:

(1) Preformed gum.
(2) Potential gum.
(3) Induction period.
(4) Copper dish gum.

In January, 1934, the A.S.T.M. committee accepted as a tentative standard a method for preformed gum. Fifty c.c. of gasoline is placed in a weighed 100 c.c. Berzelius type beaker. The beaker is placed in the well of a bath. A stream of air is directed onto the surface of the gasoline at the rate of one liter per second and at a temperature of 305-320°F. The temperature of the ethylene glycol bath is also about 320°F.

The potential gum test as used by many companies is made as follows: 100 cc of gasoline in a four-ounce bottle is placed in a 2 x 14-inch steel bomb fitted with a flange top and a pressure is applied from an oxygen drum. The bomb is then placed in a steam bath and held at 212°F. for a period of four hours. Pressure readings are taken at intervals of 15 or 30 minutes. At the end of the four-hour period the bomb is cooled, the four-ounce bottle removed, and 50 cc of the oxidized gasoline is evaporated as in the method for preformed gum shown above. The difference between this weight and the preformed gum is the potential gum.

The induction period is interpreted as the number of minutes before a drop in pressure on the bomb in the potential gum determination. If no pressure drop is incurred in four hours, the induction period is 240+ minutes. If a pressure drop occurs in one hour, the induction period is 60 minutes.

The copper dish gum test is made as follows: 100 cc of gasoline is placed in a weighed, polished, hemispherical copper dish. The dish is placed on a steam bath until the gasoline has evaporated. All of the weights of gum are reported as milligrams of gum per 100 cc of gasoline.

Cracked gasoline, as it comes from the stills, usually is almost free of dissolved gum. The gum formed by oxidation during storage remains dissolved in the gasoline, and it is this dissolved or preformed gum which chiefly concerns us with respect to engine operation. This dissolved gum is sprayed from the carburetor with the gasoline and deposits on the heated portions of the intake manifold and on the intake valves. Imperfect engine operation and loss of power may result either from a partial clogging of the manifold or delayed seating of the intake valves. In severe cases, engine failure may be caused by complete sticking of an inlet valve. No other harmful effects on the engine have been noted. Only a fraction of the dissolved gum in the gasoline is deposited in the intake system, the percentage of the total depending on the design and operating conditions of the engine. The undeposited gum is carried into the combustion chamber and burned with the charge.

The dissolved or preformed gum is the only criterion with respect to the gasoline which determines the amount of deposits that will be formed. Unstable constituents (potential gum) are not transformed into gum during the passage of the air-fuel mixture through the manifold. In other words, a very unstable gasoline or a gasoline with a high potential gum, would give satisfactory engine operation, if used when freshly manufactured.

Results of tests made by Hurn, Fischer and Blackwood[1] where 20 samples of gasoline were used in Delco engines show that:

(1) Copper dish gums are no indication of the amount of gum deposit formed in the engine. Copper dish gums of 260 and 320 mgs. gave no more gum de-

[1] National Petroleum News, Oct. 23, 1929.

posit than other samples of 18 and 15 mg. copper dish gum.

(2) Porcelain dish gums, also do not line up with engine deposits, except where they are the same as the dissolved gum.

(3) Dissolved gums agree roughly with gum deposition.

An example of results of tests made with a Buick car:

Tests—	No. 7	No. 8	No. 6
Gum in fuel—dissolved	10	25	50
Gum in fuel—copper dish	..	85	89
Miles operation	5000	5006	2722
Fuel used—gallons	315	332	203
Gum deposits recovered from:			
Heat riser and manifold	None	19	50 gm
Intake valves and parts	3.6	9	60
Total	3.6	28	110
Amt. of gum deposit gal. of fuel used	11	88	543

The test No. 7 (10 mgs. gum) showed perfect operation throughout 5000 miles. In test No. 8 (25 mg. gum) there was a noticeable loss of power after 3000 miles with no valve trouble, while in test No. 6 (50 mg. gum) the loss of power was very marked and there was slight trouble from sticking intake valves.

These tests would indicate that 15 mg. of dissolved gum would be satisfactory for use in an automobile engine.

Gruse[2] states that gum in gasoline contributes to carbon deposit if the intake mixture is not heated. Where the mixture is heated, the carbon deposit was the same with a 3, 18 and 35 mg. gum gasoline.

Bridgeman,[3] U. S. Bureau of Standards, shows that under the same operating conditions, the relative amounts of gum deposited by two gasolines is directly proportional to the amount of gum present in the gasolines.

The work of Voorhees and Eisinger[4] tentatively indicated a gum content of 20 mg. as the maximum for satisfactory performance in an engine. Standard Oil Company of New York has shown that gasoline containing as high as 50 mg. of polymers from vapor-phase clay treatment had little effect on the engine.

The A.S.T.M. committee[5] conducted tests with two gasolines containing 10 and 20 mg. gum using four cars under ordinary driving conditions. All four cars using the 20 mg. gum gasoline showed gum deposits in the intake system and on the valves, and sticking of valves was experienced with two of the cars. The tests with the 10 mg. gum gasoline, with the car most sensitive to gum, showed only minor evidences of gum deposition and in the other cars, the gum deposit varied from none to slight.

[2] World Petroleum Congress, London, 1933.
[3] Mid-year, A.P.I., Tulsa, June 3, 1932.
[4] S.A.E. Journal 24, 584, 1929.
[5] Report of Committee D2 A.S.T.M., 1932.
[6] Oil & Gas Journal, Mar. 30, 1933.
[7] Oil & Gas Journal, Aug. 25, 1932.
[8] Oil & Gas Journal, Dec. 5, 1929.

The conclusion of all work to date seems to indicate that 10 to 15 mg. of preformed gum is satisfactory for engine use.

CORRELATION OF AGEING & OXIDATION TESTS

Egloff and Morrell[6] show that the formation of dissolved gum on storage is accompanied by a corresponding loss in octane number.

	Penna. Cracked Fuller's Earth Treated	Mid-Continent Acid Treated
Dissolved gum	0	0
Octane number	70	69
After 6 mo. storage:		
—Dissolved gum	124	10
—Octane number	60	68

Storage tests conducted by Rogers,[7] Standard Oil Company (Indiana), showed that no appreciable loss of anti-knock value occurred until serious oxidation, with formation of over 15 mg. gum, had taken place. Beyond this point there was no consistent relation between the amount of gum and the extent of loss of knock rating. Some samples lost as much as three octane numbers when the gum content reached 25 mg., while others showed less change in knock rating, dropping only two octane number with a gum content of 40 or 50 mg. The use of an inhibitor to prevent the formation of dissolved gum will also prevent the loss in octane number on storage.

Herthel and Apgar, Sinclair Refining Company,[8] show the effects of storage of gasoline under different conditions: 15,000 barrels of treated cracked gasoline was stored for six months in a vented tank with only a slight increase in gum, while after 27 hours storage in a vented five-gallon glass bottle, exposed to the sun, the gum increased considerably:

	Cu. Dish Gum	Steam Oven Gum	Color
Original gasoline	33	0	30+
After 6 mo. storage in tank	45	2	29
After 27 hours in sunlight	73	26	0

These are extreme cases, but they show that storage conditions with varying temperatures, varying amounts of oxygen, etc., will give varying amounts of gum on storage. For example, a gasoline that is stored undisturbed in a tank for three months would form less gum than the same gasoline stored for the same period but handled from time to time in tank car and truck to give it more contact with the oxygen in the air.

Rogers, Bussies and Ward, Standard Oil Company, correlate the formation of gum in storage with the Voorhees oxidation test and conclude that an induction period of 400 minutes corresponds to a storage period of about one year in vented iron containers. Calculations indicate that the rate of solution of oxygen in

(*Continued on page* 84)

Instrument Maintenance

PART I

V. R. CHADBOURNE
Chief Electrical Engineer and
EARL ADAMS
Head Instrument Man, Magnonial Petroleum Company

CORRECT maintenance of instruments begins at their installation. By this is meant that it is essential that an instrument be properly installed if its maintenance cost is to be held to a minimum. Maintenance means not alone the time spent in actual repairs but also includes that devoted to ascertaining why the instrument is not functioning as was expected. Too often it is found that some little item that seemed trivial to the installing mechanic is vital to the correct action of the instrument.

It would seem that interchange of orifices on new installations would easily be avoided yet it is common to find that after the instrument has been blamed for failure to measure correctly, that all it needed was the correct orifice and not the one intended for some other place.

All manufacturers are careful to explain that all pressure connections to recorders, recorder-controllers and the like must be installed with the pipe either sloping to or away from the instrument. Yet all too often installations are found where there is little or no pitch to the pipe with now and then a dip or a rise to make an excellent trap for stray vapors or gases. Recently on a large new installation it was necessary to repipe a considerable portion of the instrument connections just because these simple facts were not thought of much importance by the installer. If it is impossible to install the pressure lines with a constant slope in either direction then it is permissible to install them with a slope in either direction from some point that may be bled occasionally of any accumulation of gases or vapors in the system.

The question of the use of seal chambers arises on nearly every installation. In general it may be said that they are necessary wherever it is necessary to measure the flow or pressure or control the flow of liquids that are corrosive, that have a tendency to crystalize in the pressure lines or that are so heavy or viscous as to cause a sluggish response in the manometer or indicator. They are also useful where the liquid to be measured is of a very gassy or volatile nature.

It is advisable where seal chambers are used on flow meters that they be installed right at the orifices with the connection pipe from the seal chamber to the orifice running horizontal so that in case of separation of liquid in the seal pots there will not be an additional manometer leg between the seal pots and the orifice. Seal chambers should be about half filled with sealing liquid or up to one inch of the pressure tap to the orifice.

The sealing liquid used must be such that it has a higher specific gravity than the liquid being measured or in event the liquid is a mixture the sealing liquid must have a higher specific gravity than that of the heaviest liquid of the mixture. The sealing liquid must be such that it will not readily mix or sludge where in contact with that being measured. Some of the common sealing liquids used in refinery operation are water, water and glycerine, and calcium chloride. The latter must be used with judgment as it corrodes brass parts and thus is more applicable to flow meters and controllers than to pressure instruments.

There are also on the market certain anti-freeze preparations for sealing liquids for use in those climates where the temperatures reach low readings. The manufacturers of these compounds usually specify with what liquids they may be safely used.

Wherever a sealing liquid is used great care must be taken that the bypass valve on the manometer is never opened while there is a flow of liquid through the orifice. For if this should occur the differential across the orifice will cause a flow through the pressure lines and force the sealing liquid out.

In the cooler climates and even in those very temperate it is often very advantageous to use some form of external heat such as steam around the pressure lines and pots of flow meters and controllers when the liquid being measured is of a heavy and viscous nature. In fact without some such aid there are times when the temperature of the liquids being measured becomes so cool that the meters or controllers cease to function.

MOUNTING INSTRUMENTS

All temperature or pressure measuring instruments should be protected from excessive vibration if repairs are to be kept from becoming excessive. On new installations where the extent of vibration of the meter supports is not definitely known before installation there may be some excuse for installing an instrument under decidedly unfair conditions. But to install an instrument where it is known that such conditions exist without

proper protection against the same is inviting trouble. Even where the instruments must be installed under such adverse conditions as on the rotor of a clay burner, it is possible by proper mountings to eliminate practically all harmful vibration at the instrument.

Instruments should be mounted where they will be well lighted and easily accessible to the maintenance man as well as the operator. It goes without saying that those difficult to see or reach are not read or worse misread by the operators and are left to the last by the maintenance crew for inspection and overhaul. Good lighting, accessibility and cleanliness are great factors toward adequate inspection and upkeep.

It would seem unnecessary to insist that all compensating lead wires on pyrometer installations should be installed without splices in the conduits and with care when this was being done that no water enters the conduit system. But often the maintenance man finds that the contractor or installing instrument man has spliced his lead wires where they had been cut short and had not been over particular in the manner of doing it, that all the low spots of conduit runs contain moisture, especially if the job was done during a rainy season, and that flexible connections to couple heads are far from moisture proof. The cure for a job so put in is to replace the splices by ones made correctly and to dry out the conduits.

THERMOCOUPLE

It must be remembered that no matter how expensive or accurate a pyrometer may be it is indicating only the results brought to it from the thermocouple. Accurately calibrated and made thermocouples are the first step in determining the real temperatures at that location it is desired to measure. Knowing this to be so it is surprising the number of instrument men who take for granted that their thermocouples are indicating the true temperature.

Those that make a practice of buying all couples from reputable manufacturers are fairly safe in this assumption as these companies do not knowingly send out uncalibrated couples. But as it is much cheaper and convenient to purchase the materials and make couples as required, operating companies with instrument departments now invariably make the couples themselves.

While the manufacture of thermocouples is a simple process yet a number of them must be rejected when

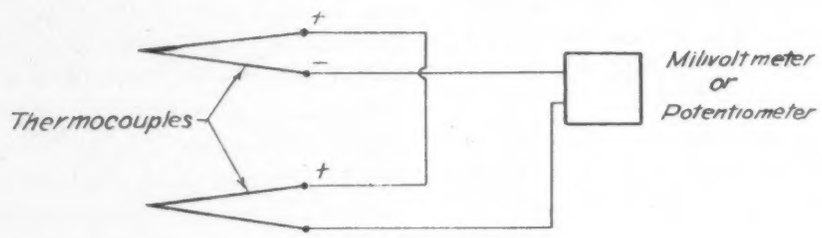


Fig 1

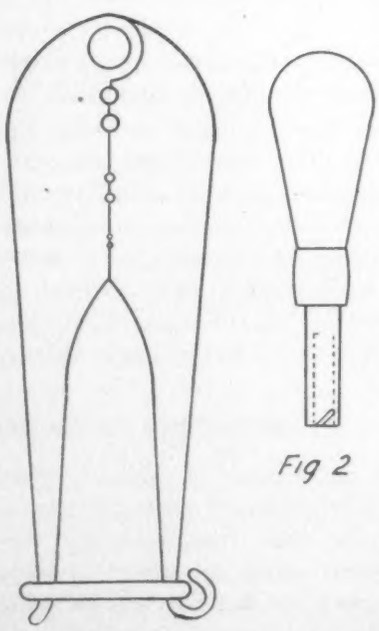


Fig 4

Fig 2

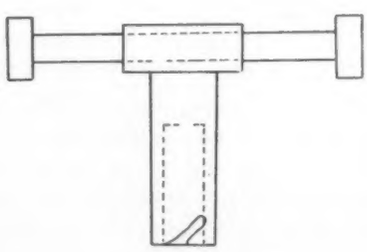


Fig 3

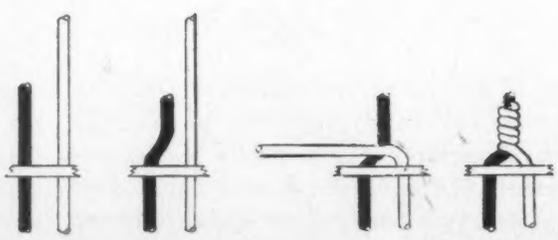


Fig 5 Fig 6 Fig 7 Fig 8

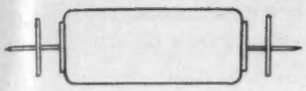


Fig 9

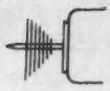


Fig 13

Fig 11

Fig 12

Fig 10

checked against a standard unless great care is taken in the selection of materials and their assembly. Even with the best of materials and of workmanship a few rejections will be necessary.

WIRE VARIATIONS

Some of these failures are due to a variation in the quality of the wire used, for even though this is manufactured with care there may be sections which deviate enough from the desired product to throw a considerable error in the couple. Probably the greater number of the rejections can be charged to poor workmanship.

No couple should ever be used without first comparing it against a standard couple, preferably at the temperature which it is to measure. Recently an instrument department in a large refinery discovered that although a group of new couples checked among themselves there was considerable error when compared with a standard couple. Investigation proved that the wire used in their manufacture, purchased from a reputable company, was not exactly the same as that previously supplied. Had not this error been discovered by checking one can well imagine the confusion that would have resulted should these couples have been placed in service on cracking units where the error would have been great enough to have upset the process.

There are several methods used in checking thermocouples:

1. By the use of a muffle furnace.
2. By the use of a metal bath.
3. Checking thermocouple at a single point.
4. Checking thermocouples in fixed installations.

The first method is the one most commonly used but there may be conditions when it may be necessary to use one of the others.

In the first method the hot junctions of the couples to be tested are tied together with an asbestos string with the standard couple inserted in the same bundle. This bundle is then placed within a pipe of slightly larger diameter than the bundle and with its inner end closed. The pipe is then placed in the electric muffle furnace. The pipe is used in order that any radiant heat which the furnace refractory might project will not affect one couple more than any other. The furnace is then brought to some constant temperature, preferably that to which the thermocouples are to be subjected. By means of a switch for quickly transferring the potentiometer or pyrometer leads from one thermocouple to another a comparison in the readings is obtained.

Some companies use a slightly different method of checking couples. The standard and the couple under check being connected in opposition (Figure 1) with the result read on a sensitive low reading pyrometer of milivoltmeter with a zero center scale. Inequalities are thus quickly shown with the added security that should the temperature of the furnace change during the checking no harm has been done. It is very convenient where the couple is to be checked at several points as the furnace temperature can be slowly changing and time is not lost in trying to stabilize the furnace at definite points.

In the second method an iron pot filled with lead or tin and covered with graphite is heated by gas or electrically. The thermocouples to be checked and the standard are inserted in short iron tubes, closed at one end, and immersed in the bath. Whenever a temperature equilibrium is reached comparative readings may be taken.

The third method, more or less approximation, can be used when a standard couple is not available. The thermocouple is checked at but one point and is then assumed to have the same error over its entire range. A convenient standard is chemically pure salt (NaCL). This is fused and the temperature allowed to drop; meanwhile the thermocouple is used as a stirring rod. As the temperature drops there is a lag when the salt freezes; at this point the pyrometer should read 1474°F.

Frequently it is necessary to check a couple without removing it. The standard couple should be placed as near as possible to the one to be checked. All conditions of the two couples must be duplicated if a worthwhile comparison is to be obtained. Where conditions such that the temperature is constant the couple to be checked can be removed and the standard inserted in its place. This can be considered only an approximate check as there is no way of ascertaining that the temperature did not change during this period.

In the manufacture of thermocouples there are a few little kinks that make this work easier if taken ad-

vantage of. In practically all of the various couples such as NC, IC or MA the positive wire is a little stiffer than the negative one. Naturally as the negative is easier to bend the positive should be left straight. A special tool (two sizes are shown in Figure 2 and 3) will be of great aid. The positive and negative wires are held by a pair of connectors (Figure 4) made to take different sizes of thermocouple wire. With the wires first held straight as in Figure 5 the positive is bent slightly as in Figure 6 and the negative at right angles as in Figure 7. The tool is then slipped on over the positive wire with the negative held by the slot in the tool and revolved until the desired number of wraps has been obtained. The positive wire is then clipped so that the ends will be the same length (Figure 8).

In fusing the ends of the couples the use of an electric arc makes a workmanlike job. One side of the circuit is attached to the vise holding the couple while the other side is connected to a carbon pencil with a handle for the convenience of the mechanic. The electric circuit is a low voltage one, usually from the secondaries of a low voltage transformer, so that a good fusing job can be obtained without burning or oxidation. In IC couples this must be guarded against carefully and to be certain that it can not occur a hydrogen flame should play over the couple ends while the operation of fusing is taking place.

The fusing will be further aided by the use of a good flux such as borax or some one of the patented welding fluxes on the market.

The use of two-hole insulators on IC couples sometimes invites trouble. This is due to the fact that under certain conditions there is a tendency for the iron wire to oxidize. This oxidation gradually builds a short between the two wires of the couple across the narrow space separating them in the two-hole insulator.

SOLDERING NICKEL

Another little kink comes in handy in the manufacture of NC couples when attaching them to a head that requires soldering instead of clamping. It is very difficult to solder nickel in a satisfactory manner. To eliminate this difficulty a short length of constantan wire is inserted in the hole with the nickel wire. The nickel and the constantan are then fused together as in the couple proper and the constantan soldered to the head with the solder surrounding the nickel-constantan junction. No error is thus introduced into the circuit for in the couple thus added the hot and cold junctions are at the same temperature and thus no potential is set up in either direction.

Although practically all the newer types of pyrometers and potentiometers use suspensions for the moving coil of the galvanometer yet there are and will continue to be in service for years those types using pivots and jewels and concentric springs. Consequently repair men must be familiar with the installation and methods of cutting these springs to their proper length.

Springs are numbered according to strength such as Nos. 6, 10, 15, 20, and have seven or eight convolutions. The older types were gold plated to prevent corrosion while the later ones are noncorrosive and will not tarnish.

The springs should be mounted about 1/32 of an inch from the ends of the moving coil, perfectly level and concentric (Figure 9). To install a spring mount the movable coil on a holder block. Grip the coil with the tweezers across the convolutions and hook over the pivot holder. (Figure 10.) Touch a soldering iron to it, being sure to hold the spring horizontal. Be sure and tin the spring and holder before soldering. After soldering use amyl acetate (banana oil) to prevent corrosion. Rosin dissolved in alcohol makes a good flux. The top and bottom springs are in opposition and are installed so that when the pointer moves up the scale the top spring unwinds and the bottom spring winds up. In calibrating instruments pulling the top spring out as shown in Figure 11 at the point indicated brings the pointer up the scale, pushing it in drives it down. The bottom spring is opposite from the top one. Pulling it out as shown in Figure 12 drives the pointer down the scale while pushing it in brings the pointer up the scale. On zero instruments if the pointer comes below 75°F. cut off the top spring or if the pointer comes above 75°F. cut off the bottom one. Springs should be concentric and when soldered in place should be equally spaced and a perfect cone or taper. (Figure 13.)

In cutting springs to length for different instruments the amount to be cut can be calculated closely.

Assume a model graduated 400°-800° F., NC with a room temperature of 75° F.

Let X = Scale range (suppressed) in geometrical degrees.
Let B = Scale range (active) in geometrical degrees.
Since angular deflection is proportional to applied EMF

$$\frac{X}{B} = \frac{\text{EMF Differential between minimum point (400° F.) and 75° F.}}{\text{EMF Differential between maximum and minimum points (800°-400° F.)}}$$

Thermocouple EMF at 75° F. = 0.0
at 400° F. = 13.0
at 800° F. = 30.2

$$\text{Then } \frac{X}{B} = \frac{13.0 - 0.0}{30.2 - 13.0} = \frac{13.0}{17.2}$$

$$X = \frac{13.0\,B}{17.2}$$

B = 70° geometrical for Model 101
Then X = 53°

Therefore the distance the bottom spring should be cut short is 53° (measured in radians) multiplied by the spring radius or 0.25".

Since 180 geometrical degrees = 3.1416 radians

$$53° = \frac{53 \times 3.1416}{180} = .925 \text{ radians}$$

$0.925 \times 0.25'' = 0.231''$ the distance the bottom spring must be shortened. The top spring must be cut long by an equal amount.

(To be concluded)

Practical Considerations for Refinery Pump Selections

L. D. WYANT

REGARDLESS of what is being done to petroleum in its various stages of metomorphosis a transfer of the material from one container to another through pipes is involved. These transfers though usually accompanied by changes of physical characteristics, are basically problems in pumping. Sometimes the material is transferred by pumping in the gaseous condition but in general, all pumping is done while the materials are in the liquid stage.

The selection of pumping equipment is of prime importance in the design of petroleum refineries. Too often designing engineers are statistical technologists who though admirably trained know little indeed about the practical art of refinery operation. Their experience with pumping equipment begins and ends with the data and pictures contained in the various pump manufacturers catalogs, and whatever favorable recommendations they are given by the various sales representatives who contact them. If a piece of equipment does not give satisfaction, the designing engineer gets hold of the sales representative. The agent assures the designer that the pump is admirably suited to the purpose in hand and if properly operated, will give satisfaction. Here the investigation is too often dropped and it is assumed the operator is at fault. In this way the same mistakes are often repeated.

The following information is needed to assist in the selection of pumping equipment.

1. Type of liquid to be pumped. Its physical characteristics and any unusual chemical characteristics, such as corrosiveness, etc.
2. Temperature variations.
3. Continuity of operation necessary.
4. Volume of fluid to be pumped.
5. Pressure required.
6. Mechanical considerations.
7. Power available, electricity, steam, gas, etc.
8. Plant layout consideration, (future extensions, permanency, etc.)

In order to discuss the practical considerations of pump selection, it is necessary to make an outline of types of pumps. These we can arrange into two classes, A and B.

A. POSITIVE DISPLACEMENT PUMPS

The positive displacement pump may be defined as a pumping mechanism so arranged that when it is operated the pumped fluid must find an outlet or rupture the pumping mechanism. Usually positive displacement pumps can be classified in one of the following groups:

1. Piston pumps.
2. Plunger pumps.
3. Rotary displacement pumps.

a. *Piston Pump:* The piston pump is generally used

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Although Wyant is well trained in the technical phases of refining, in the accompanying article he has attempted to present the subject from the viewpoint of a refinery operator, intentionally avoiding technical discussion of pump design.

The accompanying discussion was presented in two sections to the Petroleum Engineering School of the University of Tulsa. Pictures and sectional drawings of various makes of pumps were used to illustrate the different classes of pumps commonly used in the oil refining industry. Examples were taken from operating experiences of the author to illustrate the type of difficulties encountered wherever improper selection of pumping equipment was made. The views and opinions expressed in this discussion are those of the author and do not in any way reflect the views and opinions of the publishers. Discussion is invited.

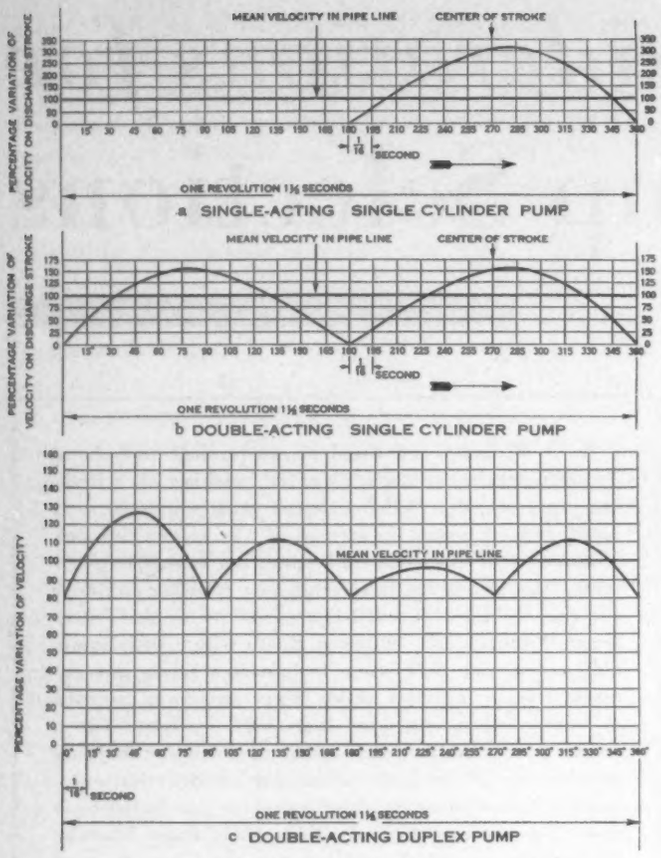

MEAN VELOCITY IN PIPE LINE
CENTER OF STROKE
PERCENTAGE VARIATION OF VELOCITY ON DISCHARGE STROKE
SECOND
ONE REVOLUTION 1⅛ SECONDS
a SINGLE-ACTING SINGLE CYLINDER PUMP
MEAN VELOCITY IN PIPE LINE
CENTER OF STROKE
PERCENTAGE VARIATION OF VELOCITY ON DISCHARGE STROKE
SECOND
ONE REVOLUTION 1⅛ SECONDS
b DOUBLE-ACTING SINGLE CYLINDER PUMP
PERCENTAGE VARIATION OF VELOCITY
MEAN VELOCITY IN PIPE LINE
SECOND
ONE REVOLUTION 1⅛ SECONDS
c DOUBLE-ACTING DUPLEX PUMP

FIGURE 1

Rate of delivery of reciprocating pumps expressed in percentage of mean velocity in pipe line.

in the steam driven, direct connected, double action, duplex pattern. This means, of course, that each pump consists of two steam power units direct connected to two pump cylinder units. A complete cycle or revolution of the pump discharges four units of liquid so there are four times the displaced piston volume discharged each cycle. The same type of pump is built and extensively used in the simplex pattern. This type of pump has only one power cylinder and one pumping cylinder and therefore discharges only two units of liquid per revolution.

b. *Plunger Type Pumps:* Plunger type pumps are extensively used in the oil industry, particularly in places where high temperatures and high pressures are encountered. They are usually horizontal direct connected units, either simplex or duplex, but are made also in the horizontal units and with rotary power drive. For low pressure and low temperature uses, they are extensively built in triplex power driven types, which have several distinct advantages for certain classes of work.

c. *Rotary Displacement Pumps:* Rotary displacement pumps are of many types. They are adaptable and preferable for a large class of service. They can be adapted to any type of rotary power. They are desirable because they give a uniform pressure free of pulsations, but in general, can not be adapted to variations in volume.

One characteristic of reciprocating pumps of all types is that variation of rate of liquid pumped per unit of time gives pulsations to the pumped liquid. Of course this pulsating is more noticeable in single cylinder pumps where the rate of pumping is zero during the period of change in direction of the piston. Figure 1, taken by permission from Goulds pumping bulletin No. 400, shows how pulsations can be reduced by constructing a pump useing multiple cylinders so arranged that the power strokes overlap.

B. CENTRIFUGAL PUMPS

The centrifugal pump may be either single or multiple stage. They are divided into two general classifications.

1. Volute pumps which have a volute casing around the impeller and built without diffusing vanes.
2. Turbine pumps in which the impeller is surrounded with diffusion vanes which direct the fluid after it leaves the impeller.

Centrifugal pumps are extensively used in the petroleum refining industry and have many desirable characteristics. Among which are:

1. Variation of amount pumped by simply partially closing of the discharge control valve.
2. Maximum pressure characteristics which prevent excessive and destructive pressure in case of accidental blocking of discharge.
3. Freedom from vibrations and pulsations in the pumped fluid.

However desirable this type of equipment is for refining use, it has been more abused than any other type of pumping equipment. This has been due almost entirely to lack of application on the part of the designing engineers in regard to correct suction conditions, and viscosity limitations.

SELECTION OF PUMPING EQUIPMENT

Proper selection of pumping equipment cannot be covered by any easily mastered and simple rules. Pumping of fluids is a science that has been studied and practiced for years. Countless men in industry have devoted their time to this division of industrial development and hundreds of types of pumps have resulted. Yet it is not unusual that a set of conditions arises which makes it necessary to design a special pumping mechanism. This is particularly true of the recent developments in the refining industry. No other industry presents such a wide range of conditions. The temperature range encountered is from 1000°F. to—140°F. Pressure conditions vary from 2000 pounds per square inch to as low as 25 to 30 milimeters of mercury absolute pressure.

A pump widely used in the petroleum refining industry is the direct-driven piston type steam pump. Usually this unit is of the duplex type, that is two

steam and two liquid cylinders and each revolution discharges four times the displaced piston volume. Space prevents the discussion of the many interesting considerations, problems, etc., of this popular type of pumping equipment. We must confine ourselves to making a list of outstanding characteristics of the duplex steam pump.

1. *Power Required.* The steam pump can be operated by steam, gas, or compressed air. Hence in almost any place or plant where pumping may be required, power is usually available.
2. *Repairs.* Repairs, (pistons, piston rods, piston rings, valves and liners) are of simple shapes which can be made in an emergency, and which are usually easy to install for repairing.
3. *Impulses.* When properly set and properly working, the discharges per revolution give a fairly regular and satisfactory flow of fluid *except,* when pumping at high pressures, or where the pumped fluid is operating, or being pumped through, or controlled by instruments. This presumes of course, that the pump is not run at too high R.P.M. and is in good mechanical condition.
4. *Easily Convertible.* In cases where the operation demands an increase in volume it is usually easy to obtain a liquid end having larger diameter pistons. In cases where higher pressures are necessary the same holds true, except also that special liners can be made reducing the diameter of the liquid cylinders to give the desired pressure ratio between available power supply and liquid pressure desired. This will often save purchasing new liquid ends. These reducing liners can be made in almost any refinery machine shop.
5. *Rigidity of Construction.* An advantage of this type pump is that it is of rigid unit construction which for emergency setting requires no special provisions. It can be mounted quickly on wood blocks or skids and temporarily used in this condition.
6. *Suction Advantages.* When properly selected and in good mechanical condition, the piston type pump will produce a suction pressure near to absolute zero. On water at atmospheric temperature, good filling can be expected with a lift as great as 18 to 20 feet, on non-volatile oils the lift will be higher proportioned to the specific gravity of the oil. However, on high lifts the pump speed must be kept low if good filling of cylinders is to be expected. On highly volatile liquids no lift can be depended upon even with good working conditions, but in emergency cases these pumps will often give surprisingly good service.
7. *Variation in Volume.* By the regulation of power supply, a variation of volume can be obtained of from 10 percent to 110 percent of the rated capacity of the pump.

The disadvantages of these types of pumps commonly noticed are:

1. High steam consumption due to:
   a. Simplicity of steam end construction. (No advantage can be taken of expanding down the steam pressures through the pump).
   b. Drag due to liquid end packing and piston rod packing.
2. Should be selected to pump liquid containing suspended abrasive materials.
3. Impulses in flow of pumped liquid are extremely hard on any type of control instrument. This is particularly true if one valve gets out of order. In cases where the pump is being operated at high pressure and high R.P.M. the vibrations set up are detrimental to piping, causing leaks and breakage in lines. This is especially true if one valve gets out of order, or if the pump does not fill properly on each stroke.
4. In cases where a line becomes blocked whether by unavoidable accident or by a mistake in closing a valve, excessive pressure will result. These excessive pressures often result in bursting of equipment which is always expensive and sometimes result in fires destructive to both property and life.

All the above discussions apply equally to both piston and plunger type direct connected pumps, except as follows:

1. The type of construction of the plunger type pump renders it not so easily convertible as the piston type.
2. Being less compact the plunger pump is less adaptable to emergency use.
3. Experience with numerous plunger pumps has shown that the suction pressure produced is less than the piston type pump. There seems no reason why this should be true and if a plunger type pump were made with this thought in mind, the pressure or the suction could, no doubt, be brought as low as on the average piston type pump, however this would require very close clearances between the plungers and cylinders
4. The plunger type pump will pump fluid containing abrasive materials with less resulting wear on the pump. This because the only tightly fitted place in the pump is the stuffing glands. However, it must not be inferred that the plunger type pump is recommended for pumping abrasive materials.

SIMPLEX OR SINGLE CYLINDER PUMPS

A simplex pump is the same as a duplex pump, except that only one liquid cylinder and one power cylinder are employed. Usually these pumps are

double acting and give one half the discharges per revolution as do the duplex type.

The factor mitigating against the simplex pump is the excessive pulsations when pumping. However, when a pump is required of such a small volume that a duplex pump would be very small, say 2 by 3 inch fluid cylinders, etc., one should select a suitably large simplex pump, because if a duplex is chosen in small sizes, the following difficulties will be encountered:

1. Small size pumps stall easily, especially after the moving valve parts are slightly worn.
2. Parts are so small they are easily broken.
3. They operate with difficulty at slow speed.

FACTORS AFFECTING SELECTION OF PISTON TYPE PUMPS

Either direct connected or power driven piston or plunger type pumps now are developed for practically any oil pumping service required. If a pump is desired for various and sundry general uses, no better pump can be selected than a steam piston type pump. For specific purposes there are uses for which they are not so desirable as other types.

They should not be selected for:

1. Pumping of anti-lubricants, e.g., gasoline, naphtha, and kerosene.
2. Pumping of material containing abrasives.
3. Pumping suitable material, but in a place when a constant service is required and when a nearly constant volume is necessary.

They will be found particularly well adapted for:

1. Pumping viscous, sticky materials such as tars and other slow flowing viscous materials.
2. Pumping where a suction lift is unavoidable.

TEMPERATURE

The factor of temperature must be considered but a type of pump is available for any temperature from minus 140°F. to plus 1000°F.

CONTINUITY OF SERVICE

If the pumping is to be continuous, as in plant operation, a reserve pumping unit must be available. If the service is intermittent with periods of two hours or more available, a single pump will very likely be satisfactory as a considerable job or revision and repairs can be done in that time.

SELECTION OF SPEED FOR STEAM DRIVEN PUMPS

A pump should be selected to operate normally at the lowest piston speed recommended by the manufacturing company. A slow speed will give the following advantages:

1. Long life of pump with lowest upkeep expense.
2. Less expense for line repairs and less loss from leaks in yard piping.
3. Better filling of pump from supply reservoirs.

There are few greater items of expense than that resulting from overspeeding of reciprocating pumps. The damage resulting from overspeeding piston type pumps comes from the hammering of valves when the piston reverses direction in a partially filled cylinder. This hammering will result in ruined valves or line leaks very quickly. When a pump is started into operation it should be started slowly and its speed increased gradually as the fluid in the line has time to increase in velocity. The pump can operate only as fast as the existing conditions will allow the cylinders to fill. Any further increase of speed is not only inefficient but damaging to the equipment in use. Unfortunately, competitive selling has resulted in manufacturers overrating their units. This has been admitted by many salesmen, however each manufacturer is forced to extend his rating of capacity equal to that of his competitors.

VOLUME TO BE PUMPED

The volume which a reciprocating pump will deliver is simply the volumetric displacement of the pump times the number of discharges per minute. In new equipment, an efficiency factor of 90 percent may be used, but with used equipment 80 percent to 85 percent will be found safer.

In calculating the volume pumped it is not accurate to assume that the pump will make the same length of stroke under all working conditions. It is safest to get the pump operating under working conditions, and measure the length of stroke which the pump is making. Usually the pump will make a shorter stroke than indicated on the name plate, however, if the pump is operating under low pressure and at high speed, the stroke will often be longer than the rating figure.

PRESSURE REQUIREMENTS

In selecting small general purpose pumps, a piston ratio to give a dead end pressure of two times the normal operating pressure will usually prove satisfactory.

MECHANICAL CONSIDERATIONS

1. A pump having a stroke twice as long as the diameter of the bore often proves most satisfactory. Pumps having short strokes do not fill as readily, particularly when pumping under conditions requiring a lift of fluid. For instance, a 4 x 12 will be found to operate much more satisfactorily than a 4 x 6.

2. Try to select a pump which is so designed that the holding or tightening nuts on the stuffing box glands are readily accessible. This is particularly important on oil pumps in refinery service. In many uses, a pump can be stopped for a few minutes to tighten stuffing box glands. In oil service this is not possible. Not infrequently an operator will be six to eight hours getting his pump speed properly adjusted, and once adjusted he will invariably take undue chances rather than stop the pump or inter-

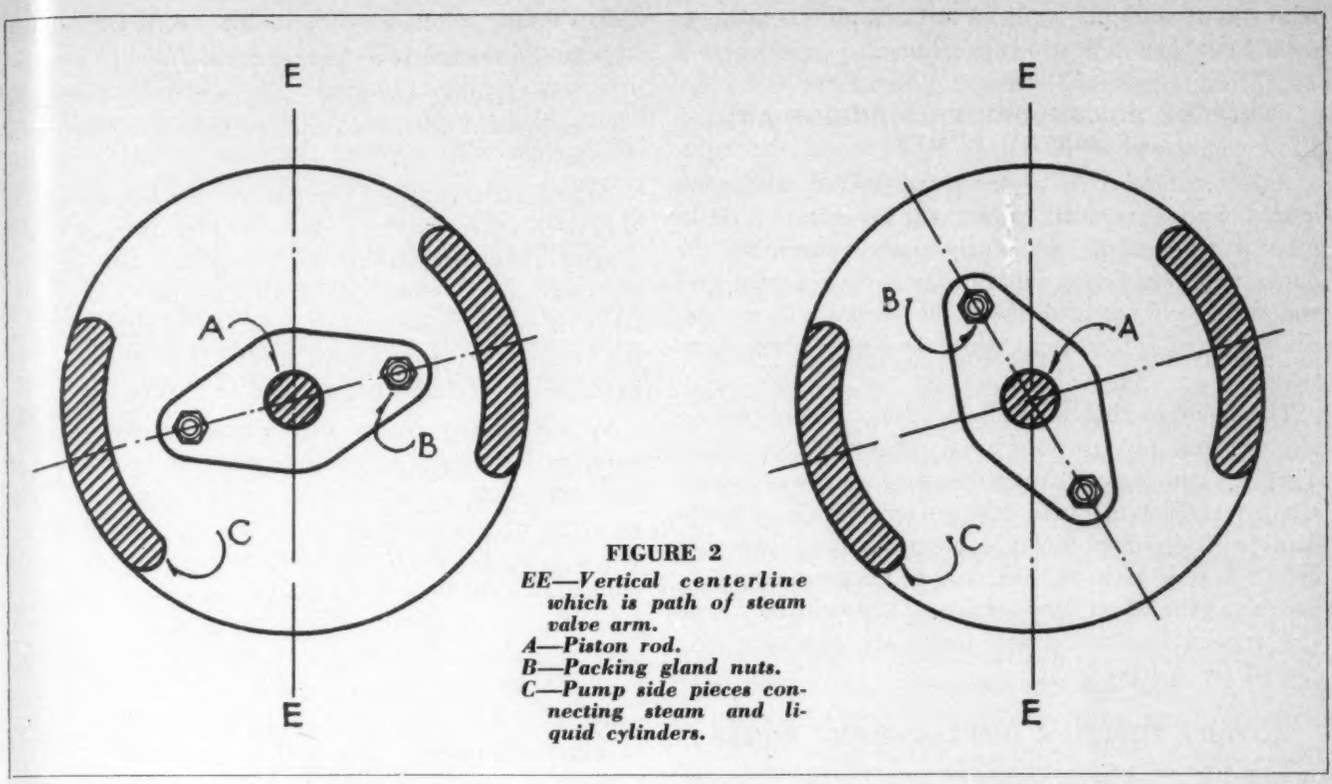


FIGURE 2

EE—Vertical centerline which is path of steam valve arm.
A—Piston rod.
B—Packing gland nuts.
C—Pump side pieces connecting steam and liquid cylinders.

fere with its adjustment speed in any way. It is remarkable how inaccessible some manufacturers of pumps have succeeded in making the tightening nuts on stuffing boxes. Figure 2 shows two arrangements of packing glands and tightening nuts. Sketch A, Figure 2, is the actual arrangement of packing glands on a hot oil pump. No doubt the designer placed the tightening studs in this position to protect them, but the position selected protected them to the extent of making them entirely inaccessible when the pump is in operation. If they had been placed as shown at B, Figure 2, they could have been easily and safely tightened with the pump in operation.

3. Not infrequently the stuffing boxes are entirely too shallow. Shallow glands must be kept very tight to prevent leaking, this not only produces excessive wear on the piston rods but further increases this wear due to compressing the packing past its resiliency. The whole purpose of the packing gland is defeated and not only must the gland be packed often, necessitating shutting down of the pump but the rods will soon wear down until they must be replaced. This, of course, applies to all pumps but particularly to reciprocating pumps.

4. See that the valve seats are screwed into place with threads. Those valve seats simply pressed into place often work loose giving considerable trouble. Further observe if the covers to the steam valve chest and covers to liquid end valve chambers can be removed without disturbing the piping. In practically every case of trouble of any kind these covers will have to be removed hence, they should be so designed as to allow inspection with the least trouble possible.

5. A detail which often causes trouble when pumps become old is the mechanical construction used to connect the steam valve rocker arm with the piston rod of the pump. The best pumps are connected with link and pins or pins which operate through rollers in slotted rocker arms. The type of construction shown at A, Figure 3 is often used. When the pump becomes worn the block A will often turn, due to the turning of the pistons of the pump, and the rocker arm C will snap out of its groove hence the pump will stop. A better arrangement is shown at B, Figure 3 where a spool

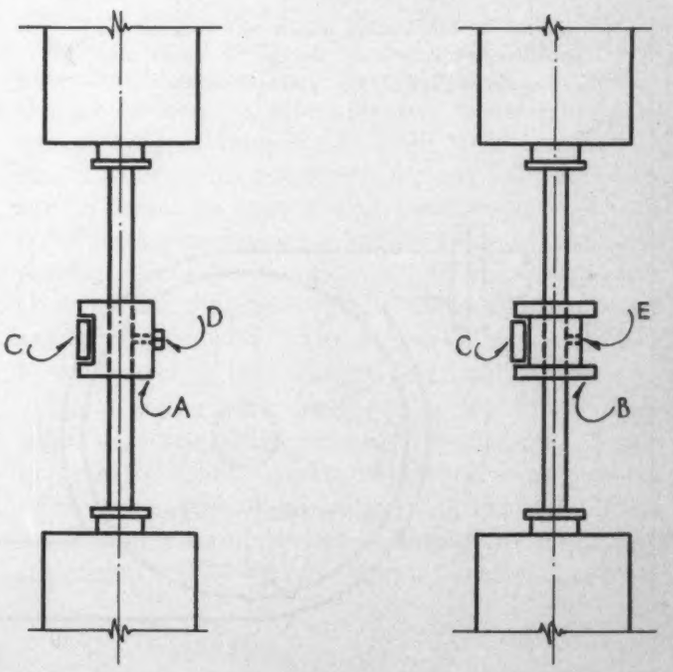


FIGURE 3

with countersunk pin is placed at E. With this arrangement the above difficulty is overcome.

TRIPLEX POWER DRIVEN PLUNGER AND PISTON PUMPS

A larger number of triplex power driven pumps are in use. They have many advantages for certain uses. In general all remarks previously made concerning the duplex types hold except that the ratio between diameter and stroke will not hold due to the necessity of a crank shaft type of construction which limits the stroke possibility.

The double-acting piston type triplex pump offers a large volume pump occupying a minimum floor space. They are compact and rugged and being power driven, are not subject to overspeeding from which so much damage to direct piston type pumps comes. They are not so flexible as to volume, and hence are not usually used for general refinery service. They demand a true and rugged foundation and hence are generally purchased for specific uses.

ROTARY POSITIVE DISPLACEMENT PUMPS

This type of pump is made in an endless number of types. They are useful when pumping any heavy viscous material but since their efficiency depends entirely on their mechanical fit, any non-lubricant or any liquid which carries abrasives will soon cause much wear.

They are highly efficient when selected for the following oil processing uses:

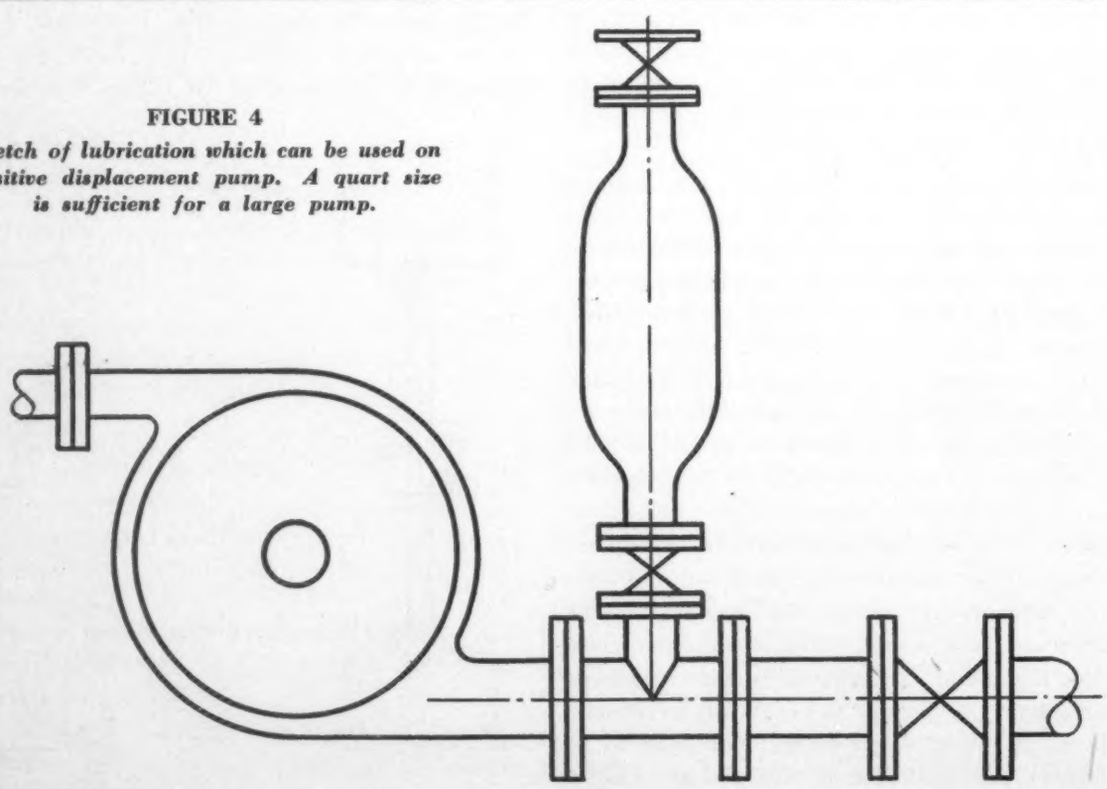
1. Loading and unloading cargoes.
2. Feeding oil to furnace burners when a constant back pressure is to be maintained.
3. For feeding chemical solutions into processing equipment where a constant ratio is to be maintained.

In general this type of pump will lift liquids admirably well, particularly if kept slightly primed which greatly assists in sealing the pump and also relieves the wear on the pump during that period of operation when it would otherwise run empty, possibly ruining the pump. This point should always be emphasized. An example of a primer is illustrated in Figure 4.

Whenever any power driven positive displacement pump is installed it should be protected by having an inclosed safety pressure relief valve installed so that in event of excessive pressure the liquid will be released from the discharge back into the suction of the pump. This should not be omitted even when the source of power is an electric motor protected with current overload relays. The inertia of the pump parts, gears, etc., and the motor rotor together with the small time delay of a relay may result in bursted pump cylinders or other equipment. This will be particularly true in case of an accidental closing of a valve during operation of the pump. However it must not be inferred that such a relief valve installation will allow one to vary the volume pumped by letting the excess return to the pump by this release valve and by-pass. If this is attempted one will soon find the release valve ruined and ineffective. Neither is it practical to adjust the amount pumped by throttling the suction valve to the

FIGURE 4

Sketch of lubrication which can be used on positive displacement pump. A quart size is sufficient for a large pump.



pump, particularly this will not work on power-driven piston or plunger type pumps. This action is the same as previously described in the paragraph on overspeeding of reciprocating pumps. The result will be ruined valves or leaking equiment or both. With rotary displacement pumps, throttling the inlet is not damaging to equipment but air will be taken into the pump through the stuffing boxes, more or less depending on the condition of the equipment. In many cases this would not be desirable. Hence, in general, a power-driven positive displacement pump should not be selected for uses where marked variation of volume is necessary.

CENTRIFUGAL PUMPS

For pumping of oils, waters, chemical solution, etc., except viscous material, the centrifugal has many advantages. Of course, the pump must be selected for its service as to metal, construction, etc.

Based on power consumption a given pump is not efficient over any considerable range of volume, but it has many points or characteristics which more than compensate for this power inefficiency.

Advantages of centrifugal pumps are:

1. Large range of volume available from a given pump. It is fortunate that as the volume of pumped liquid is diminished, although the head pressure increases and the efficiency decreases, the actual power used decreases.
2. These pumps have a maximum pressure and if a line is closed entirely there is little danger of breaking of lines, equipment, etc.
3. The usual style pump is a double suction pump, having the inlet or lowest pressure at a point surrounding the packing glands. This makes it possible to use very little pressure on the packing glands, hence the pump shaft is not worn and long service can be expected from single packings.
4. The centrifugal pump being rotary driven is not subject to overspeeding.
5. The centrifugal volute pump at the present stage of pump development for pumping oils which contain abrasive materials has many advantages.
6. The centrifugal pump is long-lived because it has very few wearing parts.

The chief difficulty with centrifugal pumps is that designing engineers will persist in so placing them that a suction lift is necessary. In refinery service experience shows that no centrifugal pump should be installed for refinery use unless it is arranged with flooded suction.

Of course, in selecting centrifugal pumps study must be given to select a pump of such design, size, etc., that it will pump at its most efficient rate. But unless a flooded suction can be arranged, and it usually can, a centrifugal pump should not be installed. This point can not be too strongly stressed. Catalogs of centrifugal pumps give tables of the suction lifts which can be expected. These tables are based on two things which are often overlooked:

1. They express the suction lift when pumping water at atmospheric temperature.
2. It is assumed that the pump is primed and pumping.

When pumping oil, particularly a volatile product, no suction lift can be calculated or justified, yet cases are on record where reputable designers have calculated the suction lift based on the proportional specific gravity of gasoline and water e.g.—if a pump was recommended for a suction lift of 7.5 feet of water it was assumed that the same pump would lift 0.75 specific gravity gasoline 10 feet.

Priming of refinery service pumps is under many circumstances dangerous if not impossible. How can one prime a six-inch suction gasoline pump? Also how prime an 18-inch suction spray pond pump on which the entire water supply of a refinery may depend. Thousands of dollars annually could be saved to the refining industry if all centrifugal pumps were installed with flooded suction.

For cargo loading of non-lubricants a centrifugal is desirable. It will give a uniform non-pulsating pressure and shifting of delivery lines, i.e., changing of points of discharge, can be done without necessity of stopping the pump.

By closing the pump suction valve sufficiently to reduce the volume to slightly less than the volume that the pump is delivering one can repack a centrifugal pump while it is under operation. This, of course, does not refer to high pressure hot oil pumps where such a procedure would be hazardous, but it has been found advantageous for many situations such as spray pond or water supply pumps, reflux supply pumps, pumps supplying cold charge to pipe stills, etc. In order to facilitate packing of centrifugal pumps their construction should be inspected to see that there is sufficient clearance to permit the removal of the stuffing box sufficiently from its gland to allow the installing of additional packing. Some pumps are constructed with so little clearance that the glands which are made in two halves and bolted together when in place, must be disassembled to enable one to remove them to permit packing.

The above remarks cover only a few of the many points to be considered when selecting a pump. It was expected to touch only those general considerations affecting the types of pumps, generally available. There are of course many detailed considerations which must come into the selection of a pump for a specific purpose.

Efficiency of Petroleum Fractionating Columns

Efficiency of a Commercial Bubble Tower

PART II

LAST month a report was given on some work which has been done on the determination of the capacity and efficiency of a laboratory packed column. Such preliminary work is necessary before a study can be made of the efficiency of a commercial tower.

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McCABE and Thiele[5] have developed a graphical method, showing the number of theoretical trays required for the separation of a binary mixture. Murphree[6] made a study of fractionation and offered the following equation, as an expression of plate efficiency.

$$Yn = Em\ Yn^* + (1 - Em)\ Yn - 1$$

in which Yn* is the vapor in equilibrium with the liquid on plate n, and Em is the Murphree efficiency factor. More recently several new methods[1,2,4,7] have been developed for estimating the efficiency of towers processing complex mixtures of three or more compounds. However, in the separation of a crude oil into gasoline, kerosene, gas oil, etc., the presence of large numbers of individual hydrocarbons precludes the use of any rigorous algebraic method of analysis which might be employed in a study of mixtures containing from two to four components.

At the outset, it is easily seen that a complex mixture must be resolved into a simple system, such as a binary one, in order for one to arrive at a solution of the problem within a reasonable length of time. The next question which naturally presents itself is the one of selecting key compounds between which the separation is actually being made. For example, if a mixture of propane, normal butane, normal pentane and normal hexane were to be fractionated so that no butane would remain in the bottoms and no pentane in the overhead distillate, it would appear that normal butane and normal pentane would be key compounds. However, it has been reported by some investigators that such a selection would necessitate a large number of plates than the amount required for actual fractionation alone, indicating that propane takes a part in causing the normal butane to go overhead, and normal hexane in causing the normal pentane to remain in the bottoms.

CORRELATION OF LABORATORY WITH PLANT DATA

The gasoline-kerosene section of a commercial tower (See Figure 1) has been studied. This atmospheric bubble tower is 3 feet in diameter and 90 feet in height, and serves as a fractionator in conjunction with a tube still which preheats the crude oil. The gasoline-kerosene section contains 11 trays including two stripping trays built into the tower itself. The partial condenser on the gasoline vapor line serves as an additional plate. The refinery is run 24 to 48 hours twice each semester to provide instruction for petroleum engineering students, and incidentally to furnish gasoline and fuel oil for the University of Oklahoma.

PLANT DATA

Crude oil (41.5° A. P. I.) from the Tonkawa field of Northern Oklahoma was fed to the tower at the rate of 10 gallons per minute and at a temperature of 750°F. with the following results:

Gasoline yield.....40% by volume
Kerosene yield.....10% by volume
Temperatures °F.
Top of tower..... 250°F.
Kerosene draw off..... 375°F.
Gasoline condensate..... 100°F.
Molal ratio of gasoline reflux to produce = 2.0
Molal ratio of steam to gasoline product = 0.705
Pressure on tower = 15 pounds per square inch absolute.
Linear velocity of vapor through tower = 1.34 ft./second.
Tray spacing = 18 inches.
Liquid Depth on trays = 1.5 to 2.0 inches.
Ratio of chimney area to cross sectional area of tower = .105.

True boiling point analyses were carried out in

*Present address, Gulf Refg. Co., Port Arthur, Texas.

the laboratory packed column, described in a recent issue of THE REFINER.

Gasoline = 60°A.P.I Vol. percent	°F.	Kerosene = 43°A.P.I. Vol. percent	°F.
I.B.P.	106	I.B.P.	342
10	155	3	374
30	214	5	381
50	267	7	388
70	316	9	394
90	395	11	400
91	400		
E.P.	440—Extrapolated.		

Engler distillations showed an end point of 405°F. for the gasoline and an initial of 400°F. for the kerosene.

DISCUSSION

All material boiling below 400°F. was arbitrarily taken to be gasoline and all material boiling above 400°F. to be kerosene. From the true boiling point distillations which were carried out at atmospheric pressure and at a rate of 2 c.c. per minute, it was found that 11 percent of the kerosene by volume fell in the gasoline range and 8 percent of the gasoline in the kerosene range since the 1 percent evaporation loss should be added to the 91 percent recovered at 400°F. It was estimated that the gasoline had a molecular weight of 115 and the kerosene 180. On this basis 5.8 mol percent of the kerosene remained in the gasoline and 15.1 percent of the gasoline remained in the kerosene. The average molal boiling point of the gasoline remaining in the kerosene was estimated to be 380°F. and of the kerosene in the gasoline 420°F. The overlapping fractions were considered to be pure compounds having these boiling points.

The number of theoretical plates required to effect separation between these two key compounds under the operating conditions in the commercial tower were determined by the McCabe-Thiele diagram. (See Figure 2). The steps involved in the method are as follows:

1. Equilibrium Curve—In the Brown-Coats vapor pressure chart for hydrocarbons, the two key compounds are located having vapor pressures of 14.7 pounds per square inch absolute at 380°F. and 420°K. respectively. The corresponding vapor pressures at different temperatures are as follows:

	Key Compounds	
Temperature	Gasoline	Kerosene
380°F.	14.7	8.7
390°F.	17.0	9.7
400°F.	19.0	11.6
410°F.	22.0	13.0

Let x = Mol fraction of the gasoline in liquid
y = Mol fraction of the gasoline in vapor
Pg = Vapor pressure of the gasoline key compound
Pk = Vapor pressure of the kerosene key compound

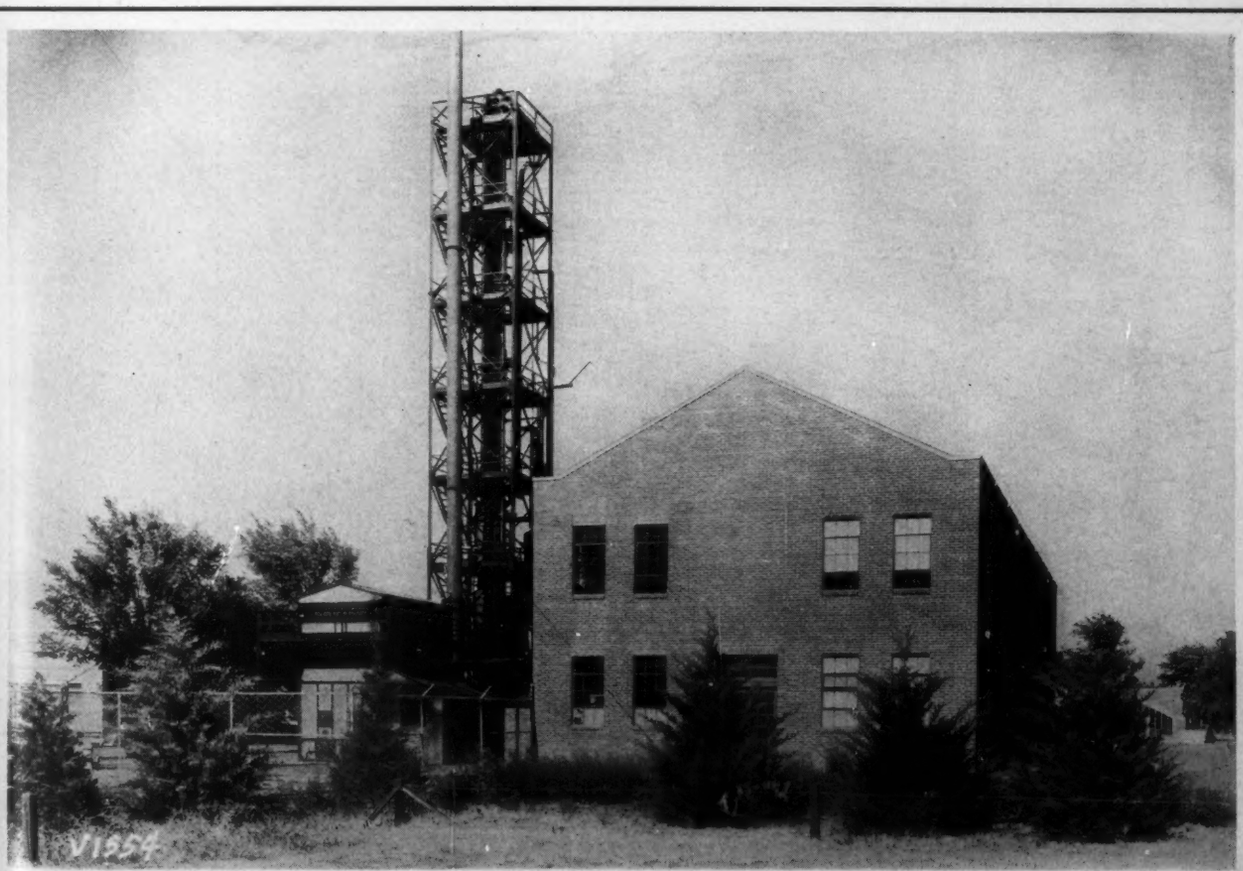
Therefore

$$Pgx + Pk\ (1-x) = 14.7 \quad (1)$$

$$y = Pgx/14.7 \quad (2)$$

Values of x and y calculated by means of equations (1) and (2) are

Temp. °F.	x	y
380	1.0	1.0
390	0.685	0.794
400	0.420	0.540
410	0.189	0.282
420	0.0	0.0



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COMPOSITION OF THE FEED

The feed into the section consists of a mixture of gasoline and kerosene in the ratio of 4 to 1 by volume. The weight and molal ratios are therefore as follows:

Feed	Mol. Wt.	Sp. Gr.	Vol. Percent	Wt. Percent	Mol. Percent
Gasoline	115	.738	80	78.5	85.2
Kerosene	180	.805	20	21.5	14.8

Composition of the Overhead Products and Bottoms According to the True Boiling Point Analyses

I. *Overhead Product*

	Vol. Percent	Wt. Percent	Mol. Percent
Gasoline	92	91.3	94.2
Kerosene	8	8.7	5.8

II. *Bottoms*

	Vol. Percent	Wt. Percent	Mol. Percent
Gasoline	11	10.2	15.1
Kerosene	89	89.8	84.9

The operating line. Referring to Figure 3, lines $x = .151$ and $x = .942$ are drawn from the x axis to the 45° slope line. From the point of intersection of the line $x = .942$ with 45° line, the operating line A F is drawn with a slope of 2/3, the ratio of reflux to vapor in the tower. From the point F, the intersection of this line with the feed line $x = 0.852$, the line F B is drawn as the operating line below the feed. In this manner the entire operating line B F A is determined.

NUMBER OF THEORETICAL PLATES

Starting from the point A, a horizontal line representing the first plate is drawn to the equilibrium curve, and from the point of intersection a vertical line is dropped down to the operating line. In like manner similar steps are drawn until the staircase reaches the composition of the bottoms. The number of horizontal steps thus formed is the number of theoretical plates in the section.

Plate efficiency. Since the section of the tower under consideration has eleven actual plates and one partial condenser for the overhead product, the number of actual plates would be taken as twelve. According to Figure 3 the number of theoretical trays required for the seperation are 10.6, which would give an efficiency of

$$\frac{10.6}{12} \times 100 = 88.3 \text{ per cent.}$$

CONCLUSIONS

A method has been outlined for the determination of the efficiency of a commercial fractionation column. Although the steps are somewhat empirical, it is believed by the authors that a more rigorous solution of the problem would not prove to be a practical one. The order of magnitude of the efficiency of the kerosene-gasoline section of this column is in line with the efficiency of separation of known mixtures in commercial towers of similar design.

LITERATURE CITED

[1]Beall—Vol. 13, Nos. 5, 7 and 9 (1934) Refiner and Natural Gasoline Manufacturer.
[2]Brown, Souders and Nyland—Ind. Eng. Chem. 24, 522 (1932).
[3]Cope and Lewis—Ind. Eng. Chem. 24, 498 (1932).
[4]Lewis and Matheson—Ind. Eng. Chem. 24, 494, (1932).
[5]McCabe and Thiele—Ind. Eng. Chem. 17, 605, (1925.)
[6]Murphree—Ind. Eng. Chem. 17, 747 (1925); 17, 960 (1925.)
[7]Obryadchakoff—Ind. Eng. Chem. 24, 1155 (1932.)

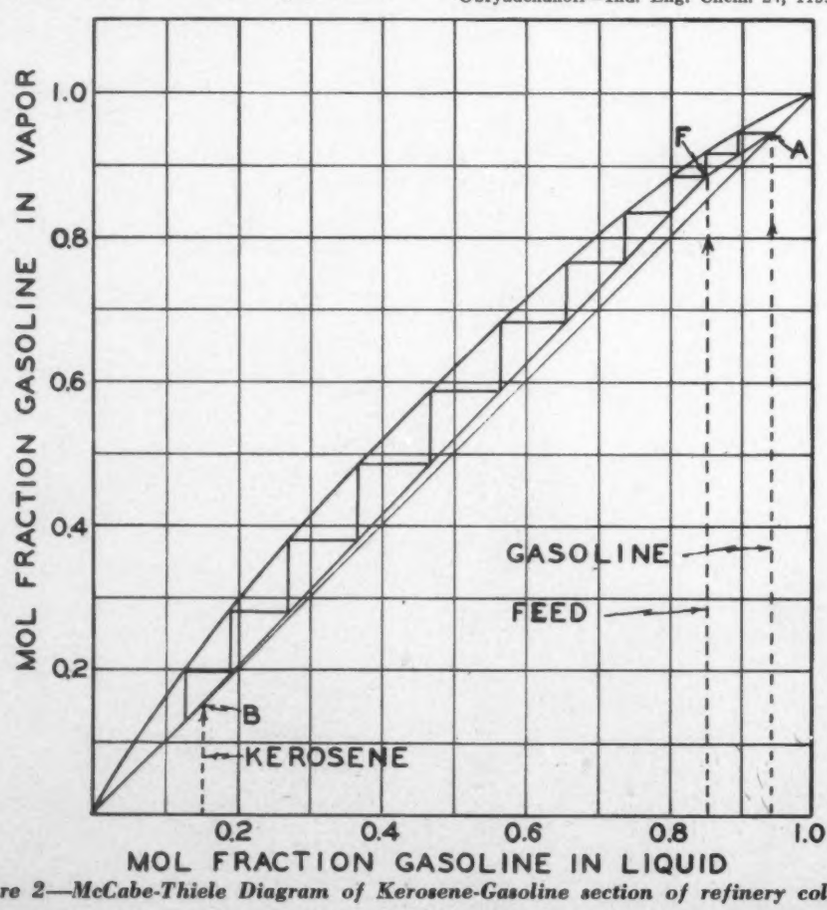


Figure 2—McCabe-Thiele Diagram of Kerosene-Gasoline section of refinery column

MANUFACTURE OF

Asphalt Products *from Santa Maria* Crudes . . .

CASMITE Oil Company, which has a refinery at Casmalia, California, designed primarily to manufacture asphalt, has a situation perhaps not found in any other field in the United States. The crude oil, or one might say, liquid asphalt, refined, is an 8° A.P.I. product, produced only in the field nearby. This heavy oil comes from a light grey shale containing no sand or other abrasives. It is free of paraffin wax, contains no ash on burning and does not form coke when placed under an elevated temperature.

Peculiar to the oil and to the zone from which it is produced is that it appears to have filtered slowly from some other retaining structure through beds of diatomaceous earth found in great abundance in that section of the country. In the process of moving through the various strata it is probable, according to officials of the company and others, that the paraffines were separated from the original oil through a selective process (if it contained them in the original composition) and was refined through moving of natural forces to be finally trapped in the shale beds from which it is now produced.

In its original state it contains 84 percent of 80 penetration asphalt and 16 percent of lighter products; kerosene distillate, Diesel oil and lubricating oil distillates. To produce this oil from the shales, it is pumped with more or less conventional equipment, but upon being exposed to normal atmospheric temperature, it congeals readily. To prevent this from occurring, it is diluted with about one part of kerosene distillate to two parts of oil. This is injected into the pumped stream at the casinghead where it comes from the tubing. The temperature of the oil as it is lifted to the surface is about 130°F. and at that temperature it is easily mixed with the solvent.

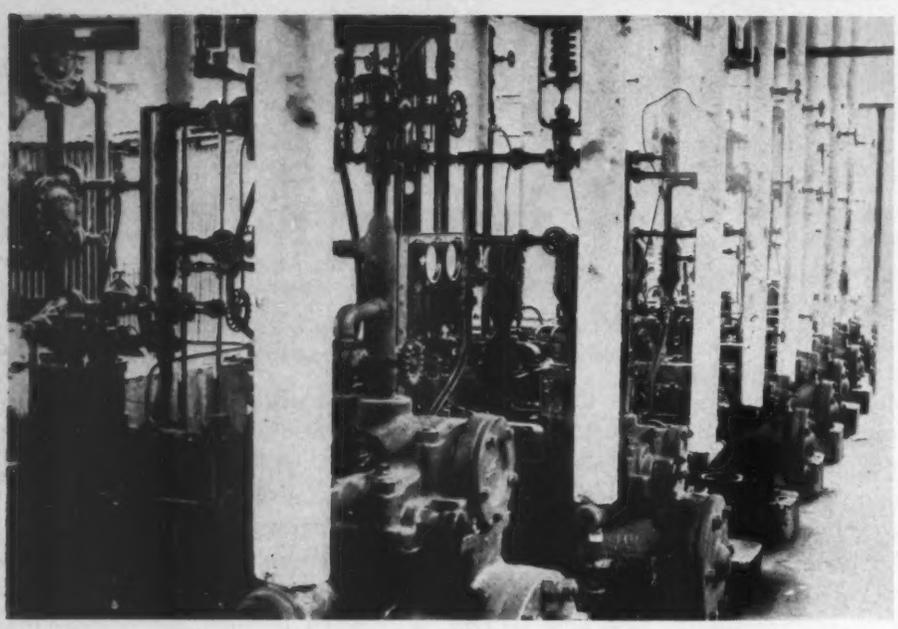
Kerosene distillate from the process of reducing the crude is used as a blending, or solvent stock, distributed to the various wells through a system of delivery lines. The diluted crude, having a gravity of about 14° to 16° A.P.I., is easily handled at the normal temperatures.

The surface condition of the country where this plant is situated is broken. The plant was built on the side of a steep hill so that gravity can perform an important part in processing the oil. As the oil contains about 15 percent water when it is pumped from the producing zone, it is necessary to remove this before running through the stills. The storage tanks and the dehydrating units were built upon the highest point above the plant, and the "wet" oil after being received in the central flow battery is pumped through the dehydrating unit. A steam heated exchanger is employed to raise the temperature of the oil sufficiently that it will break out easily, and after it has been converted from the "wet" to the "dry" stage, it is placed in storage from which the plant charging pump takes suction.

It is picked up under a gravity head of about 60 feet by a steam operated simplex reciprocating pump. A volume ranging from 600 to 1000 barrels per day is handled by this pump, taking suction on the oil which is under a temperature of 140 to 160°F. The predetermined rate of flow is maintained by an adequate volume differential recorder controller and the pumped diluted oil enters the solvent distillate, or kerosene, exchanger where a temperature ranging from 160 to 180°F. is secured. This increase over the temperature on the oil after it has been processed in the dehydrating unit is not many degrees, but because of the desire to conserve all of the heat available, it was found desirable to use this exchanger. Again, water is not too plentiful in that part of California, and in raising the temperature of the charge, the distillate has been cooled accordingly. The distillate passing through the exchanger is that normally contained in the crude, plus the volume introduced into it when

Casmite Oil Company refinery near Santa Maria, California

it is diluted at the casinghead, returned of course, with the oil as a recycle stock to be used over and over again. Directly after the crude charge has been passed through the distillate exchanger, it passes through the second unit where the hot bottoms from the processing column flow in counter current to the incoming crude. The bottoms which are reduced asphalt of varying grades, ex-



Pumps for charging, handling reflux and recycle stock and pumping out are steam driven simplex type

change with the incoming oil to secure a temperature on the cold charge of 290°F.

Under the initial pressure placed upon the charge by the cold crude pump, the oil enters the first section of tubes in the pipe still. This still is a conventional unit containing two separate sections of tubes and a bank of steam superheating coils. In the first section of tubes, the oil is heated to 550 to 650°F., depending upon the process carried out to produce a specification asphalt. If a low penetration product is desired, the temperature of the crude is carried at a higher temperature, and if a high penetration is to be the result, the lower temperature is carried on the crude. After passing through this primary bank of tubes in the pipe still, the heated charge is transferred through a six-inch transfer line which is covered with eight inches of rock wool shielded with a metallic covering, to the flash column.

The first flash is accomplished in a lower compartment of the main fractionating and processing column. This column is 60 inches in diameter, inside measurement, and 77 feet high. It was designed to operate as a straight atmospheric distillation and processing tower, or easily converted to a column operated under a vacuum. No ejectors and condensing units have been applied because it has been demonstrated that the desired quality products may be manufactured at atmospheric pressure. The column is completely insulated with rock wool, having a thickness at the top of two inches, while the base is covered with five inches of material. The entire column is sheathed with sheet metal as a protection for the insulation and painted black. The manholes are also insulated with rock wool and metallic covering, but this application was formed in such a manner that it can be removed intact when it is found necessary to inspect the interior of the tower. As the column elongates through expansion when brought up to processing temperature, the insulation was applied with long beveled joints to permit contraction and expansion.

After the crude has been flashed in the bottom compartment of the main column, it is withdrawn and pumped to the second pass in the pipe still. Three simplex reciprocating pumps were set for this purpose, using only one at a time. The suction and discharge lines are near the pumps and all are fitted with high temperature steel valves. A liquid level controller, placed in the flash compartment of the main column regulates the speed of this recycle pump, which operates a valve on the steam line leading to the pump, through a remote controlled air system. This liquid level controller was constructed from parts of an outside controller, converted so that the float operates on the level of the liquid inside the column instead of a small portion of it as in the case of customary installations. The float arm is four feet in length, so a long travel is necessary to actuate the motor valve.

All suction and discharge lines leading to and from the recycle pumps are heavily insulated with rock wool and covered with metallic sheathing. The fluid ends of these pumps are also covered, using sectional covering so it may be removed when it is necessary to repair or inspect the valves or pistons.

The partially stripped oil after it has been passed through the second section of the tube still, is heated to 650 or 700°F., depending, as in the first pass, upon the finished product desired.

Through an arrangement of stripping trays and draw off pans, the material is returned to the column where the finishing process is carried out. Steam at 800°F. is introduced into the mass to remove all of the undesirable lighter fractions not to be retained in the asphalt. Exhaust steam is used for this purpose by passing all steam from the pumps through the bank of superheater tubes in the pipe still furnace, supplemented by as much as is necessary of live steam from the boilers.

When the through-put rate has once been decided upon and operating conditions arranged so the plant is

operating in equilibrium, the one charging pump handles the desired amount of crude, passing it directly through the preliminary exchangers and other units at a uniform rate and constant velocity. The temperature of the material being processed through the two separate banks of tubes, the initial and the recycle banks, is maintained at a predetermined point through the operation of a triple compensated temperature controller. This instrument is governed by the rate of flow from the flash chamber of the main column to the second bank, which in turn controls the amount of fire necessary to carry out the process.

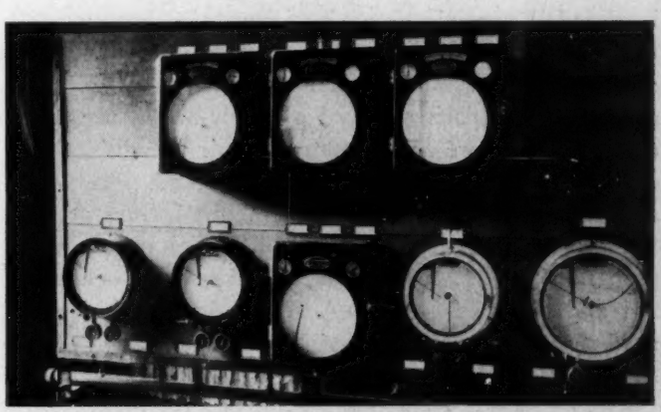
The tube still is fired with fuel oil through an atomizing burner. The fuel flow is controlled through a remote controlled valve placed on a by-pass on the fuel line to the burner. A full circulating fuel oil feed is maintained under constant pressure and volume by pumping through a heater to control the viscosity. As the oil is under control at all times throughout the operating cycle of the plant in regards to pressure, volume and temperature, the method of control is simplified. A micrometer adjusted rotor feed valve is placed on the main line from the fuel feed to the burner, set to feed a slightly sub-normal amount of fuel oil, while the actual control is placed on the bypass which permits more or less fuel to be fed to the burner as desired.

The object of this burner control hook-up is to maintain a uniform and constant temperature on both the main charge of cold crude passing through the first pass of tubes in the pipe still and the recycled material processed in the second pass of tubes. As the head on the cold charge pump is constant and the temperature uniform, the rate does not vary, but through a possible surge in the base of the column, the recycled material may change in flow, and if this occurs, the fuel to the combustion chamber of the tube still is controlled accordingly. The ports in the by-pass control valve are such that the control progresses or decreases slowly without sudden surges of heat. The control instrument is set with a certain amount of predetermined lag so that small fluctuations of flow will not affect it, but if the change in rate is prolonged it will increase or decrease the temperature by slowly opening or closing the bypass valve.

When processing this heavy stock, the recycling operation is performed to secure additional stripping so that a uniform bottom product consistent with the desired specifications will be obtained. The fractions contained in the original crude and recycled diluent flow upward through the main column to be separated into three side cuts. The first removed is a lubricating oil distillate, which comprises only one percent of the charge. The second cut consists of a Diesel oil, and the third is kerosene distillate. Three side strippers are used, one a combination column made in two sections, the upper part receiving the Diesel oil and the lower part the lubricating oil distillate. A separate column is provided to strip the kerosene distillate because of the volume handled. The amount is large not only because of the percentage contained in the original oil, but also because of the amount of solvent required to provide fluidity when handling prior to distillation and processing.

Superheated steam is also used in these side columns and the vapors removed from the material are returned to the column at the first tray above the draw-off pan from which the respective cuts are taken. Gravity is employed in removing the distillates from the stripping drums which permits the material to flow easily to the suction of the pumps. No rundown tanks are employed, as such, and the duties of the pumps are to remove the distillates, pass them through adequate coolers to final storage. Each side stripper is equipped with its individual simplex reciprocating pump to take care of the distillate received.

Each of these separate pumps not only removes the material from the base of the side strippers to the storage tanks, but also performs the duty of refluxing the various points on the column. The discharge line branches a short distance from the fluid end of the pump, one division leading to the storage and the other to the point on the column where the reflux is injected. About 25 pounds pressure is maintained on the discharge of each of these combination pumps, which is sufficient to transfer the material to the tanks and to deliver the required volume of reflux to the column. The discharge of each pump is fitted with two controllers, one on the line leading to storage and the other on the line leading to the point of reflux. Reflux rates are controlled through a thermostat, the recorder-controller being located on the instrument board in the control room. The speed of the reflux and pumping out units is controlled by the amount of liquid removed from the draw-off pans. A liquid level controller is placed at each of these points which controls the volume of steam admitted to the power end of the pumps.



Control board in Casmite Oil Company's asphalt plant at Casmalia, California

All pumps and controllers, whether indicating, actuating or recording are equipped with glycerine pots which prevent the liquids being handled, controlled or measured from entering and contacting the diaphragms of the valves or bourdon springs of recording and indicat-

ing gauges. These pots are devices made at the plant and attached to the under side of all discharge lines. Filler plugs were included in the design and gates were attached between the pots and the lines so they can be cleaned or filled when the pumps are being operated. Commercial glycerine is placed in the pots until they are filled approximately to the two thirds mark. It has been found that undiluted glycerine gives good service during the warm months, but when colder weather prevails, it is found necessary to dilute it with water. The glycerine also acts as a pulsation dampener, preventing excessive recorder and indicator spring movement. It has also been found that because of the use of glycerine in these pots and lines, deterioration of diaphragm rubbers has not occurred as often as before its use.

A recycle pump and a pumping out pump is provided for each operation with a stand-by unit which may be placed in either service. As each of these pumps performs separate duties under different conditions, an ingenious device has been placed in service which permits the use of the controller to be transferred to either of the pumps. The copper tubing leading from the controlling point to the point controlled is divided, one line leading to the steam valve on the pump normally in service for the duty of pumping out, while the other is connected to a small header near the stand-by. The recycle pump is fitted in the same manner, with a branch of the copper tubing leading to the stand-by and the other to its own control valve. If it is necessary to switch pumps, for instance the recycle unit, all that is necessary to secure smooth operation is to open the copper tubing line at the small header. This permits the steam control valve to function on the spare as well as the one installed on the pump regularly in service.

The reduced asphalt in the base of the main column is placed in special storage equipped with heating coils to maintain its fluidity, or is pumped directly to the subsequent processing equipment while hot. Several methods of preparing special products are in use, most of which are more or less conventional. Steam blowing, oxidizing stills and cut-back mixers are used. Practically all products which can be manufactured from asphalt are prepared at this plant. Two special orders were prepared for foreign shipment, one of which was colored red and the other green. A ruling dignitary in Siam used the material in the paving of garden walks at his summer home.

The laboratory tests of the crude and the three major grades of California specification asphalt are shown in the accompanying table.

By changing the operating temperature and rate of flow through the plant, it can be immediately converted for processing a lighter crude. When this is done, fuel oil bottoms are produced instead of specification asphalt, the side streams are removed having a different composition and in addition, an over-cut is taken from the column which is classed as blending gasoline stock.

All high temperature valves are steel and gates and other controls are boxed in with removable covering of rock wool sheathed with metal. Sufficient open space is provided to permit the flow of heat from the lines carrying the material to the parts of the control valves. Sample cocks on the base of the main column are also covered so the temperature of the material is transferred constantly to these points in order that the sample catcher may remove material for testing as often as desired without aplying heat to soften the asphalt in the gates.

RAW CRUDE

Gravity	8° A.P.I.
Kerosene Distillate	12 percent, 350/550°F. range
Diesel oil	3 percent, 550/625°F. range
Lube. Distillate	1 percent, 625/720°F. range
80 penetration asphalt	84 percent
Total	100

E GRADE ASPHALT

Penetration at 77°F.	244
Flash (Cleveland Open Cup)	425°F.
Melting point (ball and ring)	97°F.
Ductility at 32°F. and 77°F.	110+

D GRADE ASPHALT

Penetration at 77°F.	58
Flash (Cleveland open cup)	480°F.
Melting point (ball and ring)	123°F.
Ductility, 77°F.	110+

C GRADE ASPHALT

Penetration at 77°F.	25
Flash (Cleveland open cup)	495°F.
Melting point (ball and ring)	134°F.
Ductility, 77°F.	110+

All exhaust steam after it has served the purpose of processing and transfer of heat is returned to an adequate condenser from which it is led to a combination water softener and feed water heater. Lime and soda are used to reduce the hardness of the boiler feed water, and it flows by gravity to the supply tank. Pumps take suction here and pass the water through an exhaust steam-to-feed-heat exchanger so the water is sufficiently warm when it enters the boilers to facilitate steaming.

The plant as a whole is fully automatically controlled, having adequate instruments placed at all major points so that when it has been placed on stream and equilibrium secured, all that the operator must do is to check results of distillation and observe the recording controllers.

Gravity performs much of the functions of moving the material from the initial charge to the pumps, and the finished and semi-finished products to the various levels of processing. Cut-back mixing tanks are set on the hillside so their bases are elevated above the tank cars into which the finished material is loaded. Barreling of the harder asphalts is done at a point sufficiently high that the filled containers may be moved for shipment without extra effort.

Acknowledgement is made to O. C. Fields for permission to write this article, and to Ray Kemper, plant superintendent who provided the information incorporated in it.

Laboratory Evaluation *of* Oil Stocks

Typical Analyses and Evaluation Curves

PART 2

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SEVERAL methods of laboratory distillation were discussed in a previous paper but any distillation should be supplemented by a careful analysis of the products from the distillation. To be most effective the fractions from the distillation should be plotted in the form of curves. It is possible to run several distillations making different products in each distillation but this is expensive and often develops into a lengthy research program before the desired results are obtained. One such evaluation is recalled which involved more than 20 distillations and when the report was completed only approximate yields and data were available.

Two types of curves are useful. One type is the Differential or Mid-Percent curve. These curves show the property of each drop or fraction of material when arranged in the order in which they distill. The other type is the Integral Average or Yield Curve. An example of this type is the Viscosity Yield curve. This curve shows the viscosity of any percentage of residue material that may be produced.

DIFFERENTIAL OR MID PERCENT CURVES

These curves are so named because they may be obtained by plotting the property of each of the fractions at the mid-percentage point of the fraction. As an example the gravities of the 19 fractions from a true boiling point distillation of crude oil are shown in Table 1.

The data are plotted in Figure 1. The gravities of Fractions 3 to 18 inclusive were plotted at the mid points of the fractions, that is, for Fraction 3, the gravity (.7227) was plotted at 12.5 percent. The other fractions, Nos. 1, 2 and 19, were not plotted at the mid points but by balancing the areas bounded by the gravity line and by the curve. In other words, the curve was drawn so that the areas above and below it were equal. If smaller fractions had been collected throughout the 0 to 10 percent range and the 90 to 100 percent range, the balancing of areas would not have been necessary.

The use of the curve can be illustrated by computing the gravity of the gas oil which extends from 55 to 70 percent. The mid point of such a fraction is 62.5 percent. The gravity at 62.5 percent (Figure 1) is about

TABLE 1
Gravity Data in Crude Oil Evaluation

Fraction No.	Range of Percentage	Specific Gravity of Fraction
1	0— 5	.6506
2	5— 10	.6936
3	10— 15	.7227
4	15— 20	.7420
5	20— 25	.7583
6	25— 30	.7720
7	30— 35	.7844
8	35— 40	.7958
9	40— 45	.8067
10	45— 50	.8170
11	50— 55	.8280
12	55— 60	.8388
13	60— 65	.8498
14	65— 70	.8602
15	70— 75	.8713
16	75— 80	.8827
17	80— 85	.8939
18	85— 90	.9065
19*	90—100	.9340

*Residue.

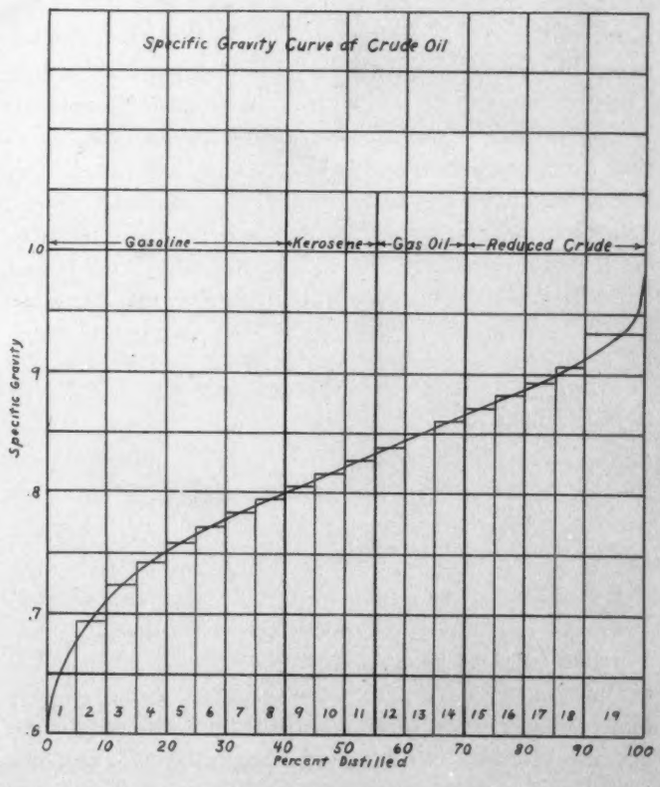


FIGURE 1

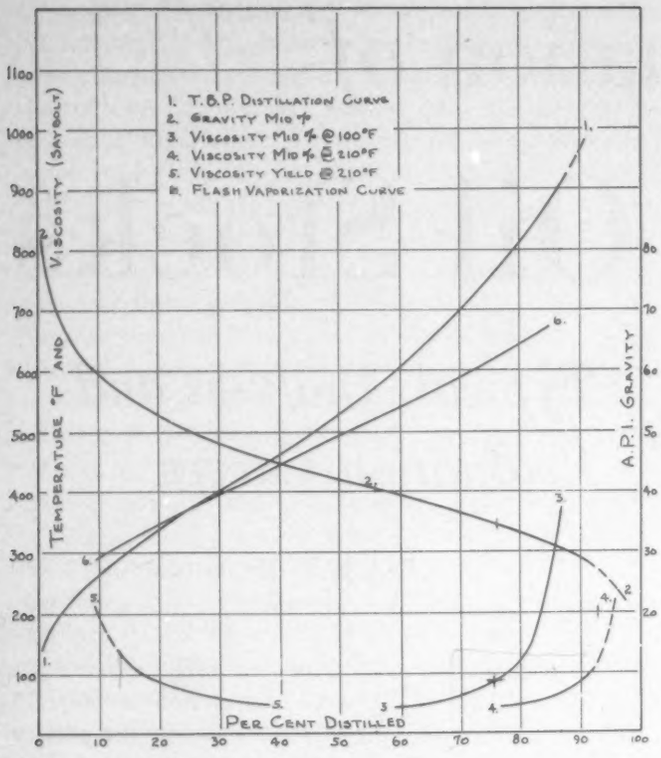


FIGURE 2

0.8495. As a check, the gravity can be computed by finding the arithmetic average gravity of Fractions 12, 13 and 14. This average is 0.8496. Likewise the gravity of the entire crude oil is equal to five times the gravities of fractions 1 to 18 inclusive plus 10 times the gravity of fraction 19, all divided by 100 and is numerically equal to 0.8173. The actual gravity of the crude oil was 0.8183 as measured by a hydrometer. This is not the same as the gravity at the mid or 50 percent point because the curve is not a straight line from end to end. The gravity of the crude oil could be obtained graphically by drawing a gravity line from 0 to 100 percent so that the areas above and below the line are equal. This line should have a gravity of 0.8173 as computed above. Likewise the gravity of the gasoline, which extends to 40 percent, is 0.7399, by balancing areas, and is not 0.751 as the 20 percent point would indicate. Thus, the gravity of a commercial fraction of material (any range of percentage) can be obtained by noting the gravity at the mid or half-way percentage of the fraction if the curve is nearly a straight line between the percentage limits of the fraction. If the curve is not a straight line, as in the case of the gasoline, the gravity must be determined by balancing the areas above and below the curve.

Examples of mid-percent curves are, the Gravity Viscosity and Vapor-temperature (distillation) Mid Percent curves. Examples of these are shown in the evaluation curves of a crude oil, Figure 2. The viscosity mid-percent curves differ slightly from the gravity curve because viscosity is not an additive property. The viscosity mid-percent curves (at 100 and 210° F.) are always plotted at the mid points of the fractions and they are always used by reading the mid point of the commercial fraction. Though there are theoretical reasons for the use of these curves in this manner let it suffice to say that accurate results are obtained by using the mid-point regardless of curvature.

INTEGRAL AVERAGE OR YIELD CURVES

These curves differ from mid-percent curves because they show the average property of a range of material rather than the property of a single drop or narrow fraction. Thus, they give the average property of a large number of drops or fractions when mixed together. Two kinds of yield curves are common—one type shows the yield of bottoms or residue product and the other shows the property of the total distillate out to a given percentage.

Examples of yield curves are the flash, viscosity, gravity, penetration, flash-point, octane and end point yield curves.

(1) The flash yield curve shows the amount of vapor that will be produced by heating a sample of oil to a given temperature under equilibrium conditions. Note Curve 6, Figure 2.

(2) The viscosity yield curve shows the viscosity of any percentage of bottom product. Note Curve 5, Figure 2.

(3) The penetration yield curve shows the penetration of any percentage of asphalt bottom product. Note Figure 6.

(4) The end point yield curve shows the end point of any percentage yield of gasoline. Note Figure 3.

These curves can be obtained by running a series of distillations and leaving different percentages of residue in each distillation. The properties of these residues (or of the distillates) can then be determined and plotted in the form of curves. However, such a method

TABLE II

Data in Asphalt Evaluation

Cumulative Percent	Vapor Temperature[1] at 760 mm deg. F.	Fraction Number	Volume of Fraction cc	Gravity A. P. I.
F. Drop	610	..	...	.....
5	740	1	100	29.5
10	797	2	100	26.0
15	836	3	100	23.1
20	868	4	100	22.3
25	895	5	100	.....
30	923	6	100	21.2
35	951	7	100	.....
40	991	8	100	19.9
45	1021	9	100	.....
50	1060	10	100	18.5
55	1110	11	100	.....
60	1130	12	100	17.3
65	1165	13	100	.....
67.5	1190	14	50	.....
70	....	15	50	16.1
73	....	16	60	.....
76	....	17	60	16.0
Residue	....	18	476	1.022[2]

[1] Hempel or 10 percent type of distillation.
[2] Specific Gravity.

TABLE III

Product	A.S.T.M. End-Point	T.B.P. Cut-Point	Initial
Gasoline	350	360	Below 200
Gasoline	375	391	Below 200
Gasoline	400	420	Below 200
Gasoline	437	459	Below 200
Naphtha	450	465	360
Kerosene	540	570	450

Breakup I—Residual Operation

Material	Percent	Gravity	Notes
437 Gasoline	40	55.2[1]	Most of loss occurs. here
540 Kerosene	16	42.5	.....
Gas Oil	7	39.5	By difference.
80 Wax Distillate	24	34.5	80 Viscosity at 100.
Residual Cylinder Stock	13	25.0[1]	135 Viscosity at 210.

[1] Computed by getting the integral average of the Gravity A. P. I. curve throughout the range of these fractions.

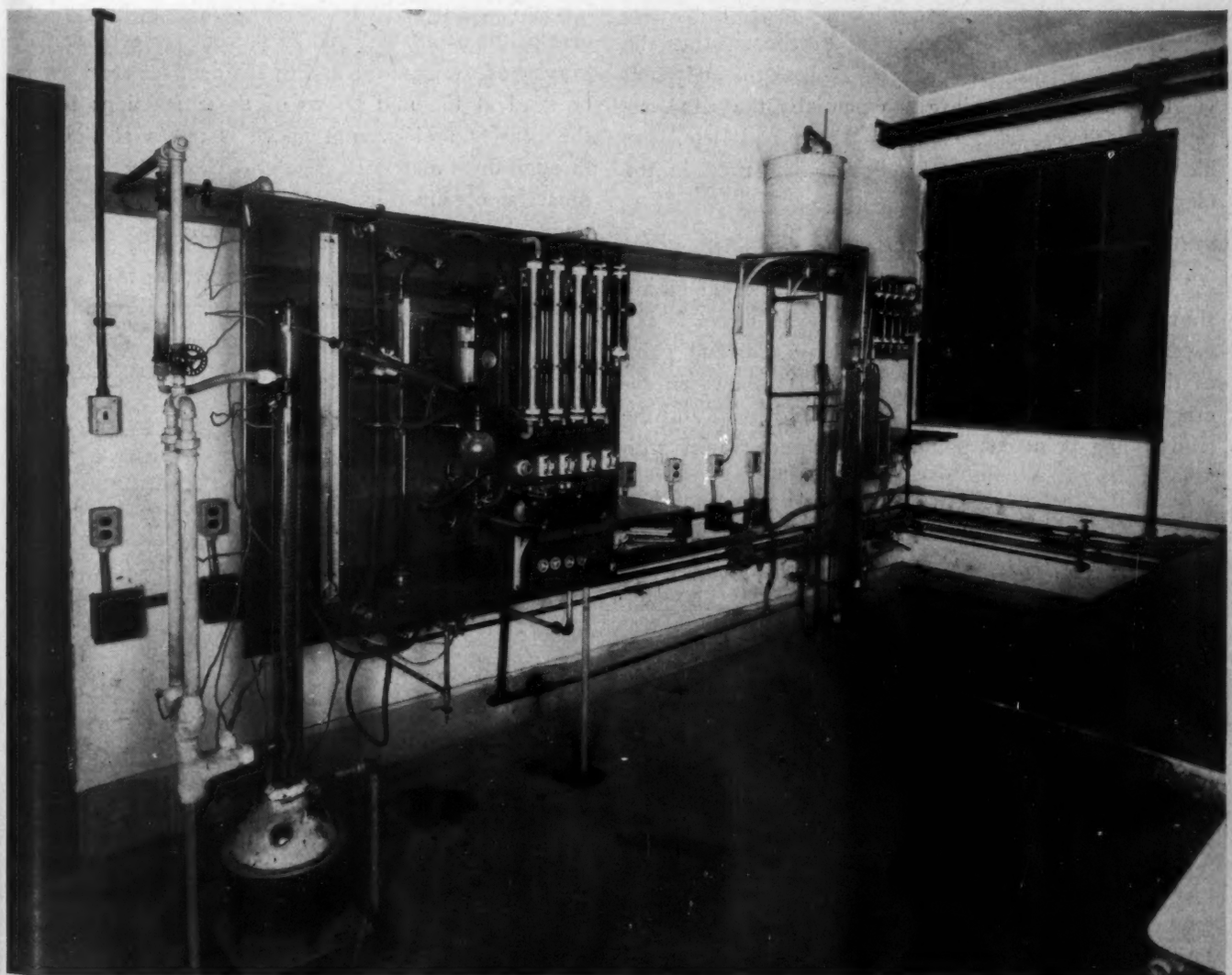
is expensive and hence the different bottoms products are usually obtained by blending fractions together to produce the several bottoms products. As an example of the construction of a yield curve consider the data in Table II that were obtained in the evaluation of an asphalt.

The residue fraction No. 18 had a penetration at 77° F. of 28 and this constitutes one point on the penetration yield curve. (See Figure 6.) Other points on the penetration yield curve were determined by blending fractions Nos. 17, 16, 15 and 14 in the proper proportions with fraction No. 18. Thus, for a 27 percent residue; 476 cc of No. 18 could be blended with 60 cc of No. 17. However, in the laboratory 95 cc of No. 18 and 12 cc of No. 17 were blended. The penetration of this blend was 55. (Note Figure 6.) Other residue asphalts were blended as follows:

	Penetration
24 percent residue fraction No. 18	28
27 percent residue 95 cc of fraction 18 and 12 cc fraction 17	55
30 percent residue 95 cc (18), 12 cc (17) and 12 cc (16)	100
32.5 percent residue 95 cc (18), 12 cc each of (17, 16) & 10 cc (15)	125

These four points were used in constructing the penetration yield curve that is shown in Figure 6.

All of the yield curves of bottom products can be



True boiling point still for gasoline evaluation and for vacuum distillation. Courtesy A. J. Smith Engineering Company.

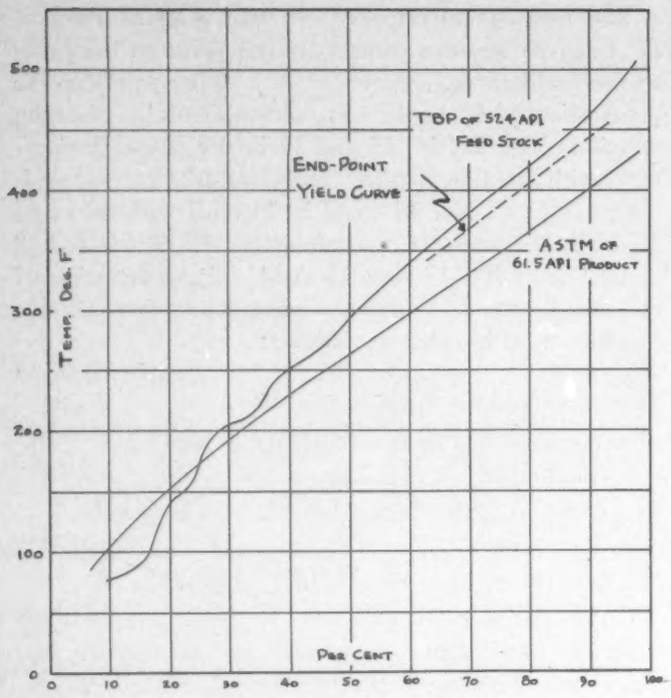


FIGURE 3

determined in a similar manner. In constructing the yield curves of distillate products such as the end point yield curve, the procedure is essentially the same except that the first fractions (Nos. 1, 2, 3 and 4 etc.) are blended and the residue fraction is not used in the blends.

TYPICAL EVALUATION ANALYSES

The evaluation curves of a paraffin base crude oil are shown in Figure 2. The end-point yield curve is not given and hence approximate data on the end point of the gasoline must be used. Table III shows an average relation between the A.S.T.M. end point and the true boiling point cut point. This relation varies with different equipments depending upon the fractionation that is obtained and hence Table III should be used with care.

Using Table III, the yields of 375, 400 and 437 end point gasoline are 28.5, 33 and 40 percent respectively (Curve 1, Figure 2). If a 437 end point gasoline is made the yield of kerosene (540° end point) will be 56 minus 40 or 16 percent. The yield of a 135 viscosity at 210° F. residual cylinder stock will be 13 percent. See curve 5, Figure 2. The yield of 80 viscosity at 100° F. wax distillate can be found on Curve 3, Figure 2. The mid point of the wax distillate fraction is at 75 percent on Curve 3. The material in the wax distillate that is heavier than 80 viscosity at 100° F. is 87 minus 75 percent and an equal amount of lighter material must be present. Hence, the yield of 80 viscosity wax distillate is two times 12 or 24 percent. These yields are summarized in Breakup I.

The gravities that are shown in the above tabulation were computed as follows. The gravities of the kerosene, gas oil and wax distillate were read directly from Curve 2, Figure 2 by noting the gravity at the mid percent points of 48, 59.5 and 75 percent respectively. The gravity of the gasoline and of the cylinder stock cannot be read at the mid points of these fractions because the gravity mid percent curve is not a straight line through these materials. The gravities of these materials must be obtained by integral averaging as discussed under the heading of Mid Percent Curves.

As an indication of the general usefulness of curves in the analysis of oil stocks, three other breakups are

TABLE IV

Yields from Pennsylvanian Oils shown in Figure 2

Material	Per-cent	Grav-ity	Other Properties	Notes
Breakup II—Residual Operation				
400 E.P Gasoline.....	33	57.4	400 E.P.	Most loss occurs here.
45 Gravity Kerosene....	13	45.	475 E.P.	.....
Distillate.....	21.5	40.2	.....	By difference—Curve 2
100 Vis. Wax Distillate..	21.	33.0	100 vis. at 100	Curve 3.
160 Vis. Cylinder Stock.	11.5	24.3	160 vis. at 210	Curve 5.
Breakup III Residual Operation				
375 E.P. Gasoline.....	28.5	58.6	.....	Table III.
450 E.P. Naphtha.....	12.5	46.5	.....	Table III.
42.5 Gr. Kerosene.....	16.0	42.5	540 E.P.	Curve 2—Table III.
Wax Distillate.....	28.0	36.0	65 vis. at 100	Curves 2 and 3.
Heavy Paraffin Oil.....	6.0	30 0	70 vis at 210	Curves 2 and 4.
220 Vis. Cylinder Stock.	9.0	22.6	.....	Curves 2 and 5.
Breakup IV—Topping for Cracking Stocks				
375 E.P. Gasoline.....	28.5	58.6	.....	Table III—Curve 2.
450 E.P. Naphtha.....	12.5	46.5	.....	Table III—Curve 2.
42—43 Kerosene.....	16.0	42.5	540 E.P.	Table III—Curve 2.
Gas Oil.....	27.0	36.0	.....	By difference—Curve 2.
26 Gravity Residue.....	16.0	26	.....	Curve 2.

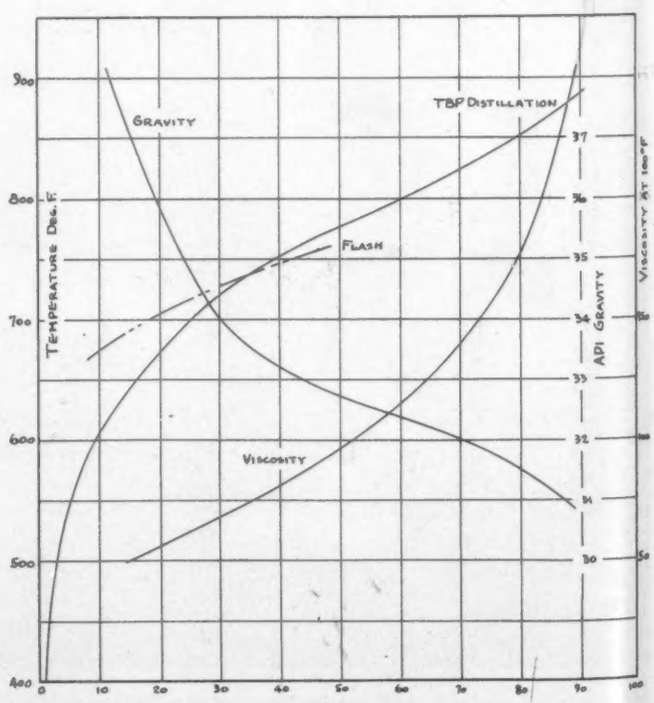


FIGURE 4

TABLE V

Realizations of Pressed Distillate

Material	Viscosity at 100 deg.	Yield		Value Cents per Gal.	Value of Finished Products $ per Bbl.
		Percent	Gallons		
Breakup I					
Viscous Neutral	300	16[1]	6.7	15.25	1.02
Neutral	150	22	9.2	10	.92
Wax Oil	100	21	8.8	5.75	.50
Gas Oil	...	41	17.2	2.25	.39
Total	...	100	.....	.....	2.83
Breakup II					
Viscous Neutral	300	16[1]	6.7	15.25	1.02
Wax Oil	100	64	26.9	5.75	1.55
Gas Oil	...	20	8.4	2.25	.19
Total	...	100	.....	.....	2.76
Breakup III					
Neutral	200	32	13.45	11.5	1.55
Wax Oil	100	32	13.45	5.75	.77
Gas Oil	...	36	15.1	2.25	.34
Total	...	100	.....	.....	2.66
Breakup IV					
Neutral	150	54	22.7	10.	2.27
Gas Oil	...	46	19.3	2.25	.43
Total	...	100	.....	.....	2.70

[1] Estimated.

presented in Table IV. These were also computed from Figure 2 and along with the breakup that was just given, present a complete picture of the yields that may be expected from this particular crude oil.

This crude does not contain a large amount of lubricating oil but since it is paraffin base it would be processed for lubricants. Breakups I, II and III are for residual operation, that is, the cylinder stock is not distilled and the wax distillate is vaporized with steam at atmospheric pressure or by using a vacuum. Breakup IV is for a topping operation. The gas oil and bottoms from Breakup IV could be cracked for the production of cracked tar and cracked gasoline.

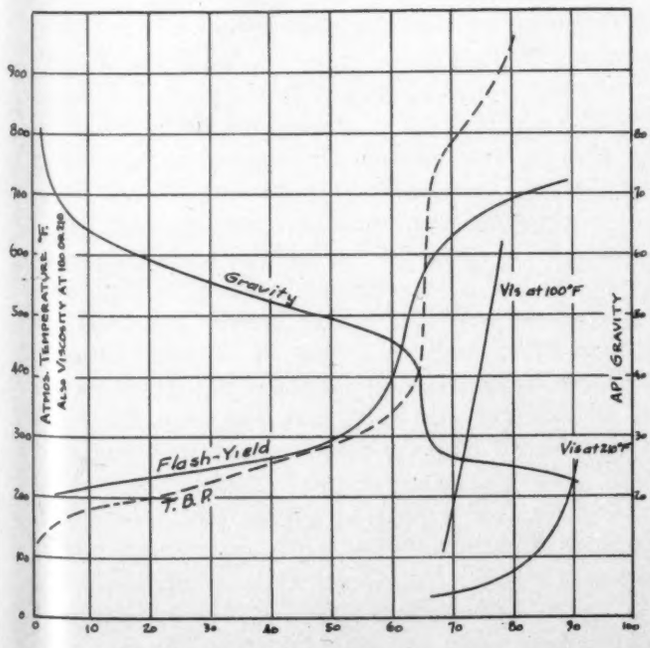


FIGURE 5

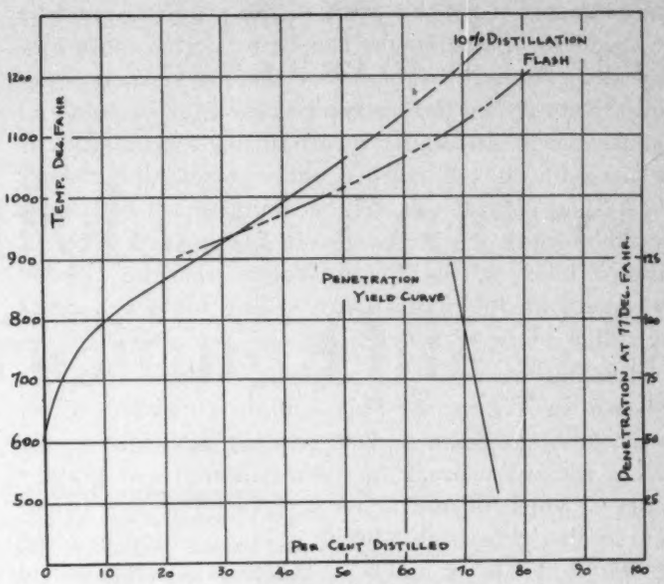


FIGURE 6

The flash vaporization or flash yield curve (No. 6, Figure 2) shows the temperature required to vaporize a given percentage when the oil is heated in a pipe still. Thus, if the gasoline, kerosene and gas oil is to be vaporized (63 percent) the oil must be heated to 555° F. If the wax distillate is also to be vaporized, then a temperature of 685° F. (87 percent) is required. When vaporizing wax distillate at atmospheric pressure, some steam would be used to reduce the temperature and avoid decomposition.

The avaluation curves for a pressure distillate are shown in Figure 3. Note that the fractionation is better for this sample than for the crude oil in Figure 2. The pressure distillate has a much narrower boiling range and fewer components; hence, the boiling point of each component begins to appear as a flat place in the distillation curve.

In this evaluation the A.S.T.M. end point yield curve was determined in the laboratory. Note this curve on Figure 3. The end-point yield curve shows that a yield of 85 percent of 425° F. end-point gasoline can be obtained from this pressure distillate. However, there is a large gas loss in the commercial distillation of such a material.

The evaluation curves for a pressed distillate are shown in Figure 4. No new curves are shown but the stock offers an excellent opportunity to select the most economical set of products. The viscosity mid percent curve at 210 is not given because neutrals are never marketed by the viscosity at 210. Table V shows four sets of yields that were computed from Figure 4. The value of the products were then computed by using the posted market prices in the Oklahoma area for August.

The realizations show a maximum range of value of about 17 cents per barrel. On a 500-barrel plant this amounts to about $2500 per month. However,

other factors than the value of the products must be considered. Some stocks can be marketed more easily than others. Not much of the 100 viscosity wax oil that is shown in these realizations can be sold and hence the practicability of producing such a stock is dependent on the market outlet which the refiner has. The neutral oils are becoming more and more valuable with the increased demand for low S. A. E. motor oils. In the Pennsylvania area the 180-200 viscosity at 70° neutrals are selling for seven cents a gallon more than bright stock.

Evaluation curves of a bright stock solution are shown in Figure 5. This sample consisted of 65 percent of naphtha and 35 percent of bright stock. Note the sharp break in the distillation and gravity curves which occurs at 65 percent. The flash yield curve also reflects this break in composition to some extent but not as much as the two aforementioned differential curves. With this solution it is possible to vaporize material that boils at 1000° F. by flash vaporization at a temperature of 700°/F. This forcefully illustrates the carrying effect that the naphtha exerts upon the bright stock.

EVALUATION OF ASPHALT STOCKS

The evaluation of the asphalt content of a stock is particularly difficult because very high temperatures must be used in the distillation. This precludes the use of the true boiling-point equipment because of the big difference in tempperature between the flask and the top of the column. Refer to Figure 5, in Article I of this series. In order to reach the very high vapor temperature of 1200 °F. (converted to atmospheric pressure) a low pressure of 1 or 2 mm must be maintained and a Hempel type still must be used. Even with these precautions the final liquid temperature is at least 750 °F. Some decomposition occurs but if the time is not too long, no harm occurs. Curves for the evaluation of asphalt in a Mid-Continent straight-run residuum are shown in Figure 6. The penetration yield curve shows that about 30 percent of 100 penetration asphalt can be produced.

Flash vaporization is a means of lowering the distillation temperature but it is not satisfactory for evaluating stocks because the fractionation is poor. In fact, flash vaporization gives a poorer separation of products than any other method of distillation. A laboratory fractionating tower can be used and this allows the use of flash vaporization but it is an expensive method. Such an equipment should be classed as a replica plant and a unit having a capacity of less than five barrels per day would probably be inoperable. Refer to Article III of this series which will appear next month, for a discussion of replica plants.

REFERENCES

1. N. A. C. Smith—"The Interpretation of Crude Oil Analyses" Bureau of Mines Reports of Investigations Ser. No. 2806 (1927).
   Method of evaluating yields by the Bureau of Mines Hempel Method. Evaluation curves and example evaluations.
2. Beiswenger & Child—"True Boiling Crude Analysis" Atlanta Meeting of Am. Chem. Society—Petroleum Division.
   Evaluation analysis and curves used by the Standard Oil Co. of N. J.
3. Robinson—"Pennzoil uses Miniature Equip. for . . . control . . ." O. & G. J. pg. 75, March 29, (1934).
   Evaluation curves of Bradford, Pa., crude oil and application of T. B. P. analysis to plant operation.
4. Trusty—"Lab. Control of Cr. Still Charging Stock Has Reduced Formation of Coke" O. & G. J. pg. 22, October 8, (1931).
   Analysis of East Texas Crude Oil by Louisiana Oil Refining Co.
5. Cromwell—"Unusual Characteristics of Michigan Crudes . . . " O. & G. J. pg. 110, March 29, (1934).
   True Boiling-Analyses of Michigan Crudes. Octane Yield curves given.
6. Trusty—"The Lab. Assay of Crude" Pet. Eng. pg. 30, June, (1932).
   The Hempel Method of Analysis.

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MAURICE PARTIOT
Consulting Engineer

THE blending machine described in the accompanying article which is known in this country as the Automixer, was invented and developed during the past few years, in France by Paul Thiberge, technical head of Les Consommateurs de Petrole, of Paris, a large lubricating oil company. During the past two years the blending machine has been introduced in the United States and applied to American blending problems through arrangements whereby Wallace, Muller & Company, Ltd., are distributors and Maurice Partiot, consulting engineer, represents the French interests. Mr. Partiot is a member of Societe des Ingenieurs Civils, Paris and Ingenieur des Arts et Manufactures, E.C.P. In this country Sun Oil Company at its Marcus Hook, Pennsylvania, plant has one installation, and through arrangement a manufacturing license has been given to that company's subsidiary, Sun Shipbuilding & Dry Dock Company. A second installation of the machine is in operation at Socony-Vacuum Oil Company's Paulsboro, New Jersey, refinery.

THE trend in refinery operations for the last few years has been to replace batch methods of treating petroleum products by methods in which such products are treated in continuous streams. The advantages of continuous treating over the batch method are well known. They permit a more accurate and more automatic control of the treatment.

PRESENT METHOD OF BLENDING

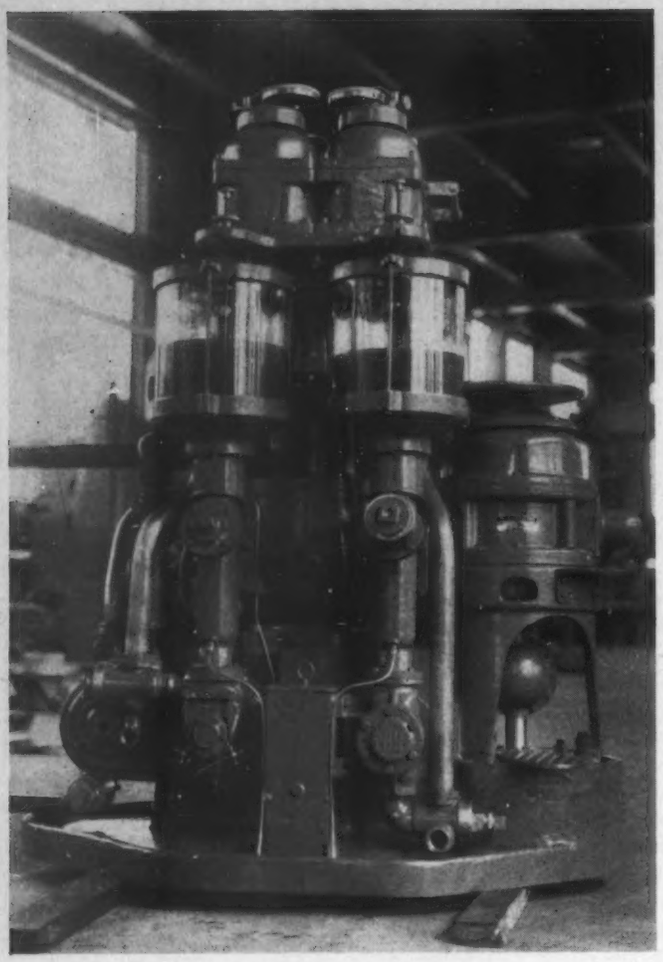
Lubricating oils are being blended at this time in the same fashion they were since blending existed. In batches of varied volume the component oils are poured, one after the other, their proportions being obtained by measuring the successive heights in the tanks in which the mixing is to take place. Steam heat is often applied and the mixture is then agitated by compressed air or by mechanical means. The blend obtained is sometimes sent into a tank storing finished blends, or the whole of the mix is immediately put into containers; or is left in the mixing tank and several orders are filled as they come directly from this mixing tank. Each batch is tested for viscosity and color before it is approved; sometimes the right specification is not obtained the first time and a correction must be made by adding one of the constituents and a second mixing. Such methods as used in the past have been fairly satisfactory until now. However, the man in charge of blending had to make up, by his efficiency and activity, for all deficiencies of that method.

In order to operate a blending plant at the lowest possible cost with the present method it would be necessary to have one tank for each finished blend sold, so that the oil could be immediately delivered when ordered, such oils being blended to replenish the supply, at such times when convenient or befitting the blending schedule. However, the cost of investment and amortization of such an installation would be prohibitive. Therefore, plant owners have fixed the number of tanks for blending or storing finished products at about one quarter, or less, of the number of blends produced within a monthly period.

When orders are filled directly from one of the predominant blends which are kept in storage, the cost per gallon of blending such order is very low; but when an order is received for a blend which is not kept in storage a special batch must be made to fill that order and the cost per gallon is considerably higher than in the first case.

All special batches cost about the same, and when a special order is made for 100 drums the cost per gallon is still acceptable, because the divider is high, but when a special batch is made to fill an order for 20 drums, or less, then the divider is low and the cost per gallon is from five to 20 times higher than in the previous case.

Another drawback of the present method is found in the practice of small purchasers of special lots, waiting until their supply has become depleted before ordering from the refinery; such special orders are usually imperatively requested for immediate delivery. The present method requires at least three hours, and any rush order upsets the blending sched-



Auto Mixer

ule of the plant. The small lots, therefore, are for this reason also, more costly per gallon. The present disadvantage becomes even more pronounced when a compounding is to be made which may include up to four and five components. If 10 drums are to be made with that many components it is an even bet that the right specifications will not be obtained at the first trial. Adjusting the mixture and other such conditions have sometimes required more than six hours and resulted in having compounded perhaps 15 drums of the said special mixture, while only 10 have been ordered. Such surplus of blended stock is depreciated in value until sold, because it must be stored until such time as ordered, or if no new order comes, the mixture must be re-worked into some other blend.

The routine losses due to the present blending method vary, according to the blends and conditions, from one half to 1½ percent of the value of all the oil blended in special batches. By the end of the year this last item reaches a considerable amount.

BLENDING AND COMPOUNDING

The new method for blending and compounding lubricating oils permits drawing continuously from the stock tanks, base oils in the right proportion, to continuously mix them in the same proportions without application of heat, and to deliver the said blend directly into containers for immediate shipment or delivery. This method is purely mechanical. The adjustment of the percentages is made by the man in charge of the blending operations and for all practical purposes the method is limited to connecting a machine to the basic stock tanks, setting dials to the proper percentage and filling the containers. When the exact quantity for which the order calls has been blended, the machine is stopped and the whole of the blend goes into the containers, thereby avoiding oil losses due to surplus.

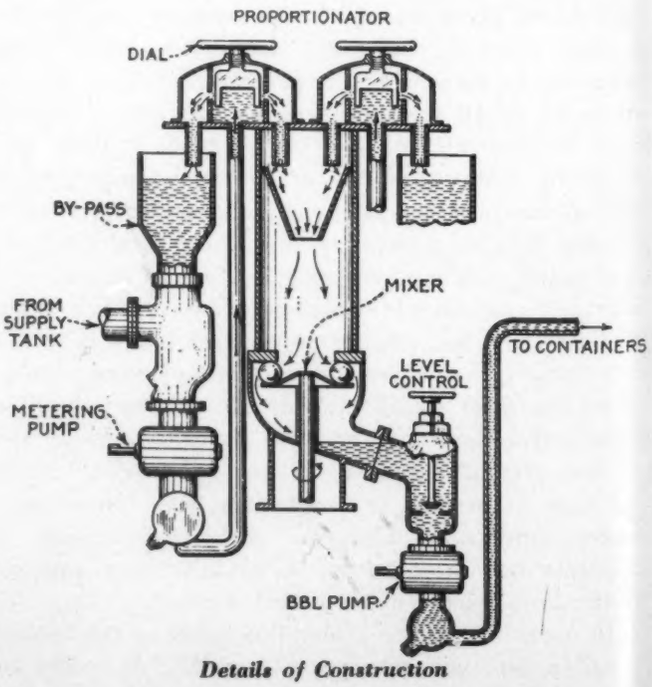
The machine, being a purely mechanical device, will repeat blends accurately under any circumstances, provided the same stocks are used.

The blends obtained are permanent and do not separate because of time or energetic centrifugation.

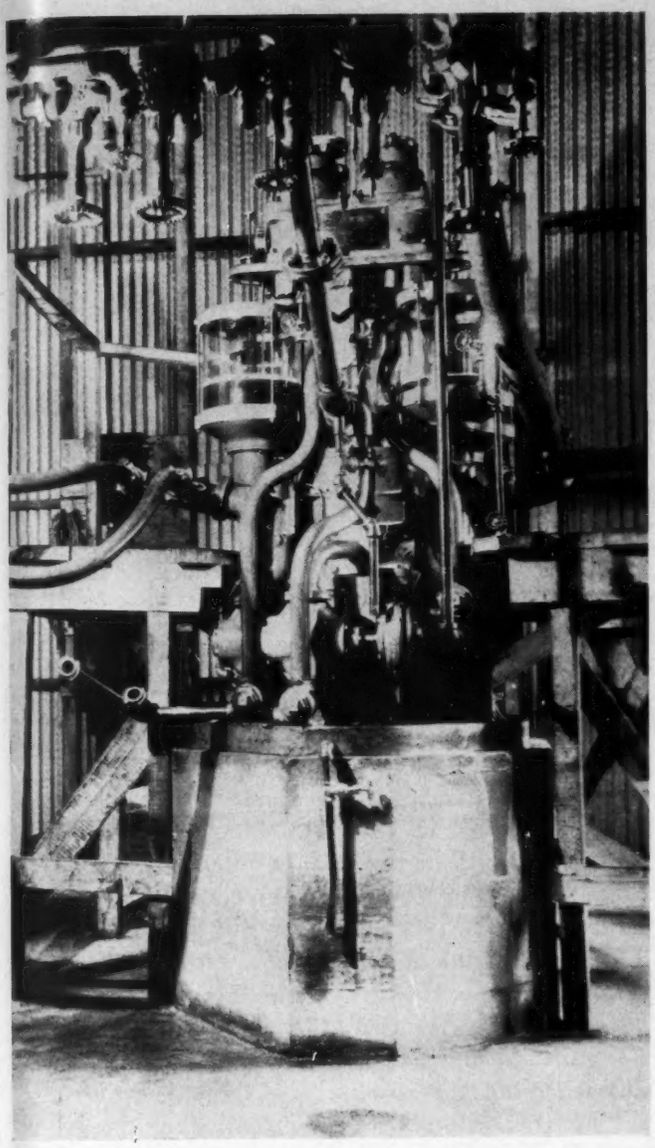
ADVANTAGES OF THE NEW METHOD

The method derives its advantages from being mechanical and continuous. The deliveries can be made directly when orders are received, just for the quantity ordered and no more. Since the containers can be filled directly from basic stock tanks, there is no need for blending tanks or for tanks storing finished products. A considerable saving in the investment is obtained, as fewer tanks are necessary, since it does away with the blending and finished products tanks. Space is saved. Most of the space in present blending plants is used for storage of finished products. Saving in heat is considerable, since the only heat which may be required in the new method is that necessary to flow the most viscous stocks from the storage tanks to the machine.

The heat used to bring the total amount of blended oil from storage temperature up to blending temperature need not now be wasted.



Details of Construction



Installed in an American refinery

Since the blending is limited to the exact quantity ordered, the saving gained in avoiding surpluses can be credited to the new method; also the floor space occupied by drums filled with such surpluses may be entirely freed for other purposes.

An item which may not be considered as a saving, but which is a big asset, is the good will resulting from immediately accepting and delivering any blend at a moment's notice; the ability to fill up the drums which a customer may send along with the order—all these conveniences being obtained without burdening the mind or taxing the abilities of the man responsible for the blending. Since the welfare of the employees is always taken into consideration by large companies, the advantage of the new method would fit in with that policy.

Other economies traceable to the method are the saving on the air compressors, on the numerous pumpings of the oils, and on the actual labor now required for the blending operation; also handling in connection with the storing and re-working of surpluses.

The method may be adapted by gradual steps to any American plant now using blending equipment. By first adopting this method for the small blends, then later on extending it to larger blends, a company with a blending plant will find itself having sufficient storage capacity, while at present the storage is a bothersome question. In such a fashion the adoption of the new method goes a long way toward solving the ever-present problem of the blender—that is, lack of sufficient storage capacity.

PRINCIPLE OF THE BLENDING MACHINE

The blending machine includes several oil dispensers disposed around a rotary mixer, out of which the oil is pumped into containers. The adjustable dispensers are connected with their respective stock oil tanks. Each dispenser includes a metering pump, a weir, and adjustable proportioner, which dispenses into the mixer the right proportion of oil, regardless of its viscosity. The balance of the flow of the same oil is returned to its respective feed line through a by-pass arrangement. Whatever quantity of oil is dispensed is immediately mixed and sent to containers. That part of the flow of oil not dispensed into the mixer goes respectively into the feed line and may be pumped back without contamination into its respective stock tank, thereby the slops are reduced to an absolute minimum.

The mixer includes a high-speed rotating disc, surrounded by a ball assembly, like a ball bearing. The streams of oil which continuously flow on the disc are exploded into very thin superimposed films, which under centrifugal force are projected through the ball assembly. The ball assembly provides a violent kneading action of the films of oil and even cold and viscous oils are perfectly blended with spindle oil when they have gone once through the ball assembly. The oil gathers under the disc and immediately flows into the barreling pump, which sends it to the containers.

ATTACHMENTS

The Automixer is delivered with attachments which permit it to operate in an automatic fashion. A predetermined meter can be set at any gallonage up to 10,000, and when the determined quantity of oil has been blended, the machine will stop.

An electric pressure switch may also be supplied. When filling a lot of drums, the drums are placed along a filling line, each with an automatic self closing filler. When the last drum is filled, the last filler closes and the pressure in the discharge line stops the machine.

The reliability of technical results have caused this method to be generally adopted in France, where the method has been applied either to existing installations and worked in combination with the pre-

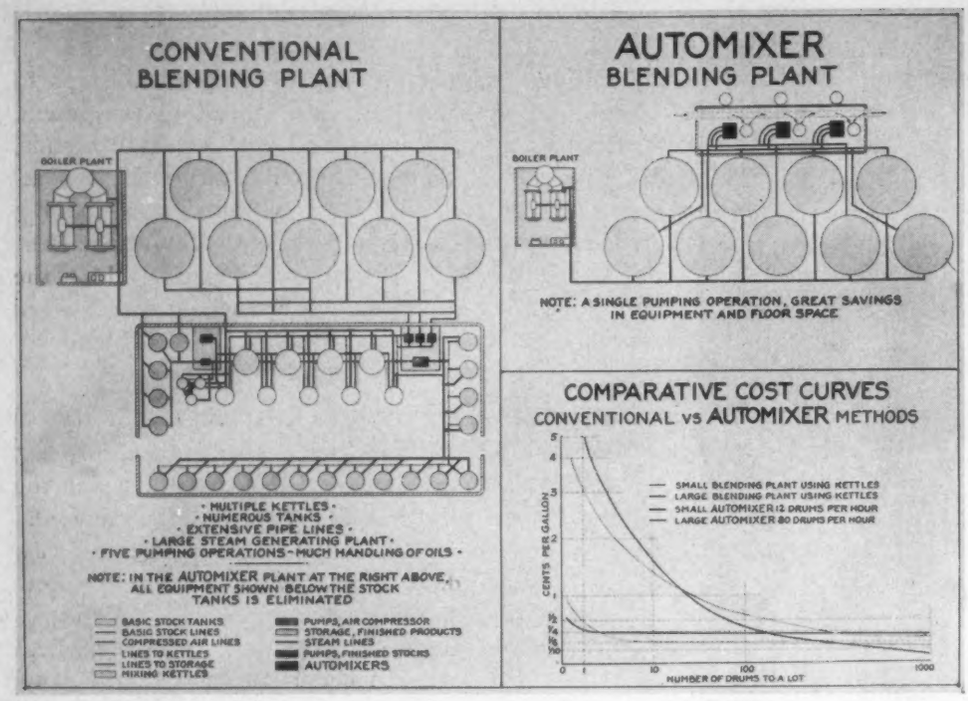

CONVENTIONAL
BLENDING PLANT
BOILER PLANT
• MULTIPLE KETTLES •
• NUMEROUS TANKS •
• EXTENSIVE PIPE LINES •
• LARGE STEAM GENERATING PLANT •
• FIVE PUMPING OPERATIONS - MUCH HANDLING OF OILS •
NOTE: IN THE AUTOMIXER PLANT AT THE RIGHT ABOVE, ALL EQUIPMENT SHOWN BELOW THE STOCK TANKS IS ELIMINATED
BASIC STOCK TANKS
BASIC STOCK LINES
COMPRESSED AIR LINES
LINES TO KETTLES
LINES TO STORAGE
MIXING KETTLES
PUMPS, AIR COMPRESSOR
STORAGE, FINISHED PRODUCTS
STEAM LINES
PUMPS, FINISHED STOCKS
AUTOMIXERS
AUTOMIXER
BLENDING PLANT
BOILER PLANT
NOTE: A SINGLE PUMPING OPERATION, GREAT SAVINGS IN EQUIPMENT AND FLOOR SPACE
COMPARATIVE COST CURVES
CONVENTIONAL vs AUTOMIXER METHODS
CENTS PER GALLON
SMALL BLENDING PLANT USING KETTLES
LARGE BLENDING PLANT USING KETTLES
SMALL AUTOMIXER 12 DRUMS PER HOUR
LARGE AUTOMIXER 80 DRUMS PER HOUR
NUMBER OF DRUMS TO A LOT

CHART A **CHART B**

vious method, or plants have been built in which oil blending is done only through the machine here described.

The machine with a capacity of 15 drums per hour has a level control of the discharge liquid which permits delivery of blended oil perfectly free from air. With such an attachment, one may discharge into drums through volumetric measuring fillers.

The machine may also be used in connection with automatic filling and canning machinery by synchronizing the speed of the equipment. It has in this respect the advantage of blending without applying any heat. Therefore, the blend may be delivered cold into cans to be automatically sealed in a single operation. The advantages of the method are obvious.

The Automixer is built to last at least 10 years without any wear. Every part has been devised with ruggedness and dependability in view. Every rotating part is mounted on ball bearings and is lubricated by constantly renewed lubricating oil manufactured through it. Charts A and B show the comparative layouts of two plants, one using the usual method, the other using Automixers. Also, the comparative costs of both methods are shown. Chart C shows the layout of a plant now operating for two years, which was built for the French Automixer. There one man can easily blend 100 drums a day, of many blends, and 95 per cent of his labor is in filling and weighing the drums. The hourly capacity of the French Automixer is approximately six drums.

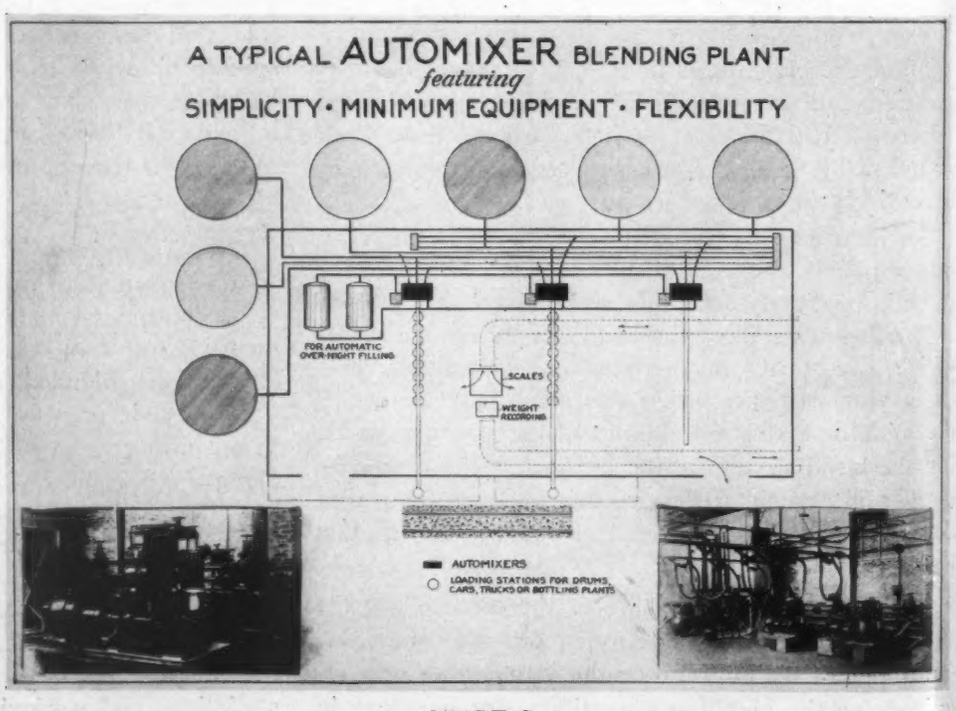


CHART C

Some Thermodynamic Data

of Application to the

Light Saturated Hydrocarbons

I. N. BEALL

WHEN heat is supplied to a solid the temperature rises until melting starts. After melting starts (if a pure compound) the temperature no longer rises, although the application of heat be continued, until melting is complete. The quantity of heat (B.t.u. in English engineering units) required to melt one pound of solid without change of temperature (melting point) is known as latent heat of fusion. After a solid has entirely melted, further application of heat will cause the temperature to rise again, until the liquid begins to boil. If a pure compound and the external pressure on the system remains constant, no further temperature rise will occur until vaporization is complete. The amount of heat required to convert a liquid into a vapor at a characteristic temperature designated as the boiling point is known as the latent heat of vaporization. In common parlance "boiling point" refers to a temperature which is characteristic for each compound at atmospheric pressure i.e., 14,696 pounds per square inch absolute. However, for every pressure from zero absolute to the critical point, there exists for each substance a corresponding boiling point. These "boiling points" when plotted versus the corresponding pressures take the form of a curve which is designated as the "vapor pressure curve." The latent heat of vaporization also changes after a characteristic and related fashion with the change of boiling point due to increased external pressure. At the (or slightly previous thereto) critical point, there is no distinction between the liquid and vapor phases, so the latent heat of vaporization becomes zero.

In the process of vaporization the heat added (B.t.u.) to effect this change per unit weight (one pound) performs two functions, namely (1) To overcome the internal cohesive forces acting between the molecules in the liquid state and (2) To do the external work of expansion i.e., increase the volume from liquid (small) to that of a vapor (large) against external pressure. The first phenomenon is known as the internal latent heat of vaporization, and the second as the external latent heat of vaporization. In English engineering units, the basic work unit is the foot-pound. 550-foot-pounds per second or 33,000 foot-pounds per minute equal one horsepower. The mechanical equivalent of heat (International Steam Conference 1929) translated into English units is 1 B.t.u. = 778.3 foot-pounds.

The volume of one pound of saturated vapor in cubic feet is designated as the specific volume, thermodynamic notation the corresponding V_2 and the volume in cubic feet of one pound of saturated liquid as V_1 by the same notation. The external heat of vaporization may then be calculated from the vapor pressure data and specific volumes by the formula.

$$l = \frac{144\,(V_2 - V_1)\,P}{778.3}$$

Where P = vapor pressure in lbs. sq. in. abs.

THERMODYNAMIC PROPERTIES

The following data for hydrocarbons shown in Table 1 will serve as illustration of the points discussed in the introductory discussion.

CRITICAL TEMPERATURE

In Table 1 all of the values are observed values with the exception of the last two columns, which are calculated from the equation.

In Tables 1 to 4 it will be noted all values are expressed in English Engineering units. These thermodynamic values are therefore of direct application to engineering problems in equipment, design and plant operation. The accuracy is probably within two percent.

CHARACTERISTIC EQUATIONS OF STATE

The latent heat of vaporization (total) may be calculated from the vapor pressure curve by a modification of the Clausius-Clapeyron Equation.

$$L = R\,\frac{T_1\,T_2}{T_1 - T_2}\left(1 - \frac{P}{P_c}\right)\log_e \frac{P_1}{P_2}$$

Where R = 1.986, T_1 and T_2 (abs. °F.) are temperatures from the vapor pressure curve corresponding to pressures P_1 and P_2 expressed in lbs. abs. per sq. in., P is the mean value (m. c. p.) of P_1 and P_2 and P_c is the critical pressure. For accuracy T_1 and T_2 are taken at 2° F. intervals i.e., the arithmetic and geometric means are the same. The latent heat, L corresponds to $T = \frac{T_1 + T_2}{2}$

An example of the calculation will be given further along in the discussion. Dieterici gives the following

DEVIATION OF VALUES OF γ WITH TEMPERATURE FOR LOWER NORMAL PARAFFIN HYDROCARBONS
TEMPERATURE - DEGREES FAHR.
TEMPERATURE - DEGREES CENT.
VALUES OF γ = Cp/Cv
32°F
122
212
302
392
482
572
662
752
0°C
50
100
150
200
250
300
350
400
1.30
1.25
1.20
1.15
1.10
1.05
1.02
CH4
C2H6
C3H8
C4H10
C5H12
C6H14
C7H16
C8H18

equation for calculating the internal latent heat of vaporporization:

$$U = CRT \log_e \frac{V_2}{V_1}$$

Where U = the internal latent heat (molal), C = a constant, R = 1.985 V_2 = specific volume of 1 lb. of saturated vapor expressed in cubic feet, and V_1 that of 1 lb. of liquid by the same notation. It is therefore possible after establishing the constant C to deduce a characteristic equation for each substance.

For example, Ethane.

$$Ml = CRT \ln \frac{3.7453}{0.0305}$$

M = Mol. wt. of ethane = 30.05

L = Internal latent heat of vaporization of 1 lb. of ethane, (taken here at — 100° F. = 360° Abs.) = 171.4 (cf Table 1)

C = Unknown constant

R = 1.985

T = Absolute temp. in this case 360° Abs.

ln = lg_e (Naperian)

V_2 = Spec. Vol. saturated vapor (360° Abs.)

V_1 = Spec. Vol. saturated liquid (360° Abs.)

Substituting numerical values in the equation:

$30.05 \times 171.4 = C \times 1.985 \times 360 \times 4.8122$

$C = 1.521$ (av. 7 values)

Substituting $CR = 1.521 + 1.986 = 3.021$

and converting Naperian to Briggs or common logarithms.

$$\ln \frac{V_2}{V_1} = 2.3026 \left(\log V_2 - \log V_1 \right)$$

and combining $Ml = U = 6.9562\, T (\log V_2 - \log V_1)$

Therefore to compute the value of U at any temperature on the vapor pressure curve for ethane the above equation may be used. As illustration (refer to Table 1)

0° F. = 460 Abs.; $V_1 = 0.0357$; $V_2 = 0.5650$

$C = 6.9562 + 460$ (log. 2.71 — log. 0.029)

$C = 1.575$

The average of the C values from the formula derived from the best is C = 1.521 which is a constant in the formula for ethane. The different values from the formula are tabulated below at the corresponding temperature from the vapor pressure curve.

Having thus established the value of the constant Cl for ethane in the equation,

$$L_1 = CRT \ln \frac{V_2}{V_1}$$

it is now possible to calculate the entire latent heat data from the vapor pressure data by using it (C) in conjunction with the modified Clausius-Clapeyron equation as previously given in this article.

For illustration for pentane (normal)

$T_1 = 142°$ F. + 460 = 602

$T_2 = 140$ °F. + 460 = 600

$P_1 = 32.1$ lb. sq. in. absolute

$P_2 = 31.0$ lb. sq. in. absolute

$P_c = 485.4$ lb. sq. in. absolute

R = 1.986 gas constant

$P = \frac{P_1 + P_2}{2} = 31.55$ (arithmetic mean)

Ln = $\log_e$ (Naperian) = 2.303 log 10

Substituting numerical values in the equation:

$$L = \frac{1.986 \times 602 \times 600}{2} \left(1 - \frac{31.55}{485.4} \right) \ln \frac{32.1}{31.0}$$

$$= 358{,}672 \times 0.935 \times 0.028 = 10{,}043 \text{ B.t.u.}$$

$$l = \frac{10{,}043}{72.1} = 140 \text{ B.t.u.}$$

Therefore the calculated total latent heat of vaporization for pentane at 141° F. is 140 B.t.u. Mol. Wt. Pentane = 72.1. The external latent heat is calculated at 141° F. to be equal to 15.2 B.t.u. by the formula:

$$l = \frac{144\ (P)\ (V_2 - V_1)}{778.3}$$

Substituting calculated numerical values in the equation

TABLE 1—ETHANE

Temperature		Vapor Pressure Abs.	Specific Volume Cu. Ft. Lb.		Latent Heat of Vaporization		
°F.	°Abs.	#/0"	Liquid V_1	Vapor V_2	Total	Int.	Ext.
—100	360	32.2	0.0305	3.7453	193.5	171.4	22.1
— 50	410	95.5	0.3228	1.3812	178.6	154.7	23.9
0	460	222.3	0.0357	0.5650	155.4	133.6	21.8
50	510	442.3	0.0410	0.2571	113.9	96.2	17.7
60	520	503.0	0.0427	0.2128	101.0	85.2	15.8
70	530	568.3	0.0452	0.1736	84.6	71.1	13.5
80	540	641.3	0.0503	0.1299	61.6	52.2	9.4
89 4	549.4	708.54	0.0730	0.0730	0.0	0.0	0.0

TABLE 2—PROPANE

Temperature		Vapor Pressure Abs.	Specific Volume Cu. Ft. Lb.		Latent Heat of Vaporization Btu.		
°F.	°Abs.	#/0"	Liquid V_1	Vapor V_2	Total	Int.	Ext.
—75	385	6.2	.0267	14.4928	190.5	174.0	16.05
—50	410	12.6	.0273	7.7519	184.5	166.42	18.08
—30	430	20.3	.0279	4.9261	179.0	160.48	18.52
—20	440	25.4	.0283	4.0000	176.0	157.26	18.74
—10	450	31.4	.0281	3.2573	173.5	154.64	18.86
0	460	38.2	.0290	2.7100	170.5	151.45	19.05
20	480	55.5	.0297	1.9011	165.0	145.70	19.30
40	500	77.0	.0306	1.3699	159.0	139.81	19.19
60	520	107.1	.0316	1.0101	153.0	133.48	19.52
80	540	142.8	.0326	.7692	146.0	126.35	19.65
100	560	186.7	.0339	.5917	138.5	119.05	19.45
120	580	239.7	.0353	.4587	129.0	110.16	18.84
125	585	253.7	.0358	.4329	126.5	108.42	18.08

TABLE 3—ISOBUTANE

Temperature		Vapor Pressure Abs.	Specific Volume Cu. Ft. Lb.		Latent Heat of Vaporization		
°F.	°Abs.	#/0"	Liquid V_1	Vapor V_2	Total	Int.	Ext.
—20	440	7.4	.0261	11.0011	165.5	150.35	15.15
0	460	11.6	.0226	7.1942	160.5	145.01	15.49
20	480	18.2	.0272	4.6729	156.0	140.24	15.76
40	500	27.9	.0278	3.2154	151.0	134.44	16.56
60	520	38.7	.0284	2.2779	146.0	129.80	16.20
80	540	53.9	.0291	1.6611	140.5	124.15	16.35
100	560	73.7	.0299	1.2300	134.5	118.05	16.45
120	580	98.0	.0308	.9259	127.5	111.28	16.22
140	600	126.8	.0318	.7143	120.5	104.47	16.03

TABLE 4—BUTANE

Temperature		Vapor Pressure Abs.	Specific Volume Cu. Ft. Lb.		Latent Heat of Vaporization		
°F.	°Abs.	#/0"	Liquid V_1	Vapor V_2	Total	Int.	Ext.
0	460	7.2	.0259	11.1111	170.5	155.64	14.86
20	480	11.6	.0264	7.2464	167.0	151.26	15.74
40	500	17.7	.0270	4.8781	163.5	147.54	15.96
60	520	26.3	.0274	3.4014	159.5	143.02	16.48
80	540	37.6	.0281	2.4570	155.0	137.87	17.13
100	560	52.2	.0287	1.8116	149.5	132.22	17.28
110	570	60.8	.0291	1.5798	147.0	129.47	17.53
120	580	70.8	.0295	1.3793	143.5	125.72	17.78
130	590	81.4	.0299	1.2107	140.5	122.63	17.87
140	600	92.6	.0303	1.0695	137.5	119.59	17.91

TABLE 5—ETHANE

TEMPERATURE		VAPOR PRESSURE		C.
°F.	°Abs.	Gauge	Abs.	
—100	360	17.5	32.2	1.465
— 50	410	80.8	95.5	1.522
0	460	207.6	222.3	1.575
50	510	427.6	442.3	1.528
60	520	488.3	503.0	1.531
70	530	553.6	568.3	1.495
80	540	626.6	641.3	1.528

89.4 Crit. Temp. Average C=1.521

$$Ml = CRT \log_e \frac{V_2}{V_1}$$

$$147.7 \times 72.1 = 1.70 \times 1.986 \times 601 \ln \frac{V_2}{V_1}$$

$$\ln \frac{V_2}{V_1} = \frac{124.8 \times 72.1}{1.70 \times 1.986 \times 601} = 4.246$$

or antilog $\frac{V_2}{V_1} = 69.9$ = ratio of specific volume of vapor to specific volume of corresponding liquid.

The accuracy of the calculated value is largely determined by the measurements of P_1 and P_2, as small changes in the ratio $\frac{P_1}{P_2}$ make relatively large changes in the natural log. (Naperian) It will be noted in the tables given of the thermodynamic properties of the hydrocarbons that the latent heat of vaporization decreases with increasing temperature and pressure. However, as was shown in a previous article in this journal the specific heat of the liquid increases with the increase of pressure on the system.

SENSIBLE HEAT

The sensible heat of a vapor or gas is equal to the total latent heat of vaporization plus the quantity of heat necessary to raise the temperature of the liquid to the boiling point from some arbitrarily selected zero point, usually 32° F. Thus for example the total heat of water vapor (steam) at 212° F. and atmosphere is given as 1150.2 B.t.u., which is equal to the heat (h_f) required to raise the temperature of water from 32° F. to 212° F. = 180.0 B.t.u. plus the internal energy of evaporation = 897.3 B.t.u. plus the external heat of vaporization = 72.9 B.t.u.

$h_f = 180.0 + 897.3 + 72.9 = 1150.2$ B.t.u. for steam at its normal boiling point. The same applies to the hydrocarbons. This data, together with the entropy and other physical and thermodynamic data, may be used for the construction of Total Heat—Entropy Charts (Mollier Diagrams) which find such extended practical application to the solution of engineering problems.

ENTROPY

The second law of thermodynamics gives the entropy equation.

$$dQ = T\,dS \text{ or}$$

$$\Delta S = \frac{\Delta Q}{T}$$

Where S = Molal entropy expressed as B.t.u., Q is the heat difference between two different energy levels and T is the absolute temperature. Small s and small q designate a weight basis such as 1 lb. The entropy change for an ideal gas is expressed by the equations:

$$S_2 - S_1 = C_v \ln \frac{T_2}{T} + R \ln \frac{V_2}{V_1}$$

$$S_2 - S_1 = C_p \ln \frac{T_2}{T_1} + R \ln \frac{P_2}{P_1}$$

$$S_2 - S_1 = C_v \ln \frac{P_2}{P_1} + C_p \ln \frac{V_2}{V_1}$$

The symbols used in thermodynamic notation, C_2, being assumed as a constant in the integration. The change of entropy for a substance with temperature at constant pressure is expressed by the equation:

$$\Delta S = S_2 - S_1 = \int_{T_1}^{T_2} C_p\, d \ln T$$

And for constant volume by:

$$\Delta S = S_2 - S_1 = \int_{T_1}^{T_2} C_v\, d \ln T$$

Assuming the heat capacities independent of the temperature, using small temperature intervals a close approximation may be made in integration by the use of the equations:

$$\Delta S_p = 2.3026\, C_p \log_{10} \frac{T_2}{T_1}$$

at constant pressure

$$\text{and } \Delta S_v = 2.3026\, C_v \log_{10} \frac{T_2}{T_1}$$

at constant volume.

Where S is known at small intervals corresponding to the temperature. T_1 and T_2 the specific heat at constant pressure and the specific heat at constant volume may be closely approximated. By division the above equations yield.

$$\frac{\Delta S_p}{\Delta S_v} = \frac{C_p}{C_v} = \gamma \text{ (Gamma)}$$

The Gamma (γ) function is used as the exponential of PV in adiabatic compression: $PV\gamma = K$.

HEAT REQUIREMENTS

Assume for illustration that a liquid condensate consisting substantially of propane C_3H_8 is at a temperature of 10° F. and an external pressure of 109.3 pounds gauge 124.0 absolute. What quantity of heat will be required to vaporize one pound of liquid? At 124 lbs./sq. in. absolute the corresponding temperature from the vapor pressure curve is 70° F. At 10° F. the heat of the liquid is 5.5 B.t.u. (reference temperature zero °F.) and at 70° F. it is 41.0 B.t.u. Therefore the difference in heat content of the liquid between 10° F. and 70° F. is 41.0—5.5 = 35.5 B.t.u.

The total (external and internal) latent heat of vaporization at 70° F. and 124.0 lbs. sq. in. Abs. is 149.5 B.t.u. Therefore the heat requirements are 149.5+35.5=185.0 B.t.u. Let it be further assumed that saturated steam at five pounds gauge 19.7 pounds, absolute is available for vaporization of the propane under the assumed conditions. What would be the theoretical quantity of steam required to effect total vaporization of one pound of propane? From the steam tables the following data taken at 20 pounds absolute t = 228° F., h_f = heat of liquid = 196.1 B.t.u., latent heat of vaporization = 959.9 B.t.u. If perfect condensation takes place, and steam condensate (water) from the trap is 105° F. then h_f at 105° F. = 74.7 B.t.u., as the total heat given up

by the steam on condensation and cooling off the condensate form 228° F. to 105° F. = 959.9 + (196.1 — 74.7) = 108.3 B.t.u. Therefore $\frac{185}{1081.3} = 0.171$ lb. of steam at five pounds gauge per pound of propane. The actual quantity would be slightly greater than this to allow for the quality of the steam and the efficiency of heat transfer. The specific volume of one pound of steam is given as 20.1 cubic feet. at this temperature and pressure. That of propane vapor is 0.883 cubic feet. The factor for the steam meter requirements therefore would be $20.1 \times 0.171 = 3.4371$ cubic feet per pound of propane, or for 1000 pounds of propane vaporized 3437.1 cubic feet of steam are required. The piping requirements for steam may therefore be calculated and also the amount of heating surface from the overall coefficient of heat transfer.

In the absence of data as to the heat required for the vaporization of hydrocarbon mixture it may be assumed within the limits of accuracy for engineering calculations that the latent heat of the mixture is the sums of the latent heats of the components. The calculations would apply to the portions vaporized rather than to the total mixture. The proportions vaporized are determined by the amount of heat added and the relative volatility of the components as determined by Raoult's Law, with such appropriate correction factors as may be necessary, applied. Methods for calculating the relationship between liquid mixtures and their saturated vapors, have already been discussed by the writer and elsewhere in the literature. In all calculations pertaining to vaporization it should be borne in mind that the total heat of vaporization includes (1) the B.t.u. required to raise the temperature of the liquid to the boiling point. (2) the B.t.u. required to overcome the cohesion between the molecules and (3) the heat to overcome the resistance to the increase volume from that of a liquid to a vapor. The "Heat Content" of a vapor may therefore be summed up as follows: Heat Content of Vapor = Heat of liquid + internal latent heat + external latent heat. For a superheated vapor, the amount of heat required to raise the temperature above that of the saturated vapor must be added to the foregoing. There seems to be considerable confusion at present as to the significance of the terms, as they are frequently meaningless unless defined.

SPECIFIC HEAT

"Specific Heat" is used to designate the quantity of heat expressed in thermal units such as B.t.u. required to raise a unit weight of a substance (1 lb.) through one degree (1° F.) Specific heat unless defined may have six interpretations, namely (1) Specific heat at constant pressure (2) Specific heat at constant volume (3) Instantaneous specific heat at constant pressure (4) Instantaneous specific heat at constant volume (5) Mean specific heat at constant pressure and (6) Mean specific heat at constant volume. In practically all engineering work the mean specific heat values are used. It is the average specific heat between designated temperature limits. In a previous article the specific heats of some of the saturated liquids hydrocarbons were given. (Refiner, Vol. 14, No. 1, Jan. 1935). To the heat of vaporization must be added the total heat required to raise the liquid to the boiling point in order to get the total heat of vapors. The specific heat of the vapors must also be known in order to calculate the amount of heat units for superheating. Any vapor above the saturation temperature is said to be superheated. This superheat must be removed before the vapor will condense. A definite thermodynamic relationship exists between the specific heat at constant pressure C_p and that at constant volume, namely: $C_p - C_v = 1.985$ which is based on the ideal gas laws, that is upon the assumption of a perfect gas. The ratio of $C_p/C_v =$ Gamma (γ) is a very important function as it is used in computing the work required for adiabatic compression and expansion. This, too, is a variable not only for separate substances but also with both pressure and temperature. A chart which will be found useful in calculating the work of compression for hydrocarbons from C_1 to C_8 is given for various temperatures in the chart. For pressures up to 10 atmospheres, they may be used with fair accuracy and an error will probably not separate them 5 percent. Equations for calculating the work of compression have already been given and may be found in various engineering handbooks. The comparative exponential function designated as s or R may be computed from the equation:

$$s = \frac{\log P_2 - \log P_1}{\log V_1 - \log V_2}$$

Where P_2 is the final pressure (absolute) P_1 the initial pressure V_1 the initial volume and V_2 the final volume. It is therefore possible to compute the s value for a given gas by metering the suction and discharge from the compressor and from reading of the intake and discharge pressures in lbs. absolute. Such values are usually about 85 percent of the true Gamma values for the mixtures.

It will be noted from the chart that the Gamma values are progressively lower with the ascension of the hydrocarbon series from CH_4. They also become lower with the temperature. This signifies on the basis of the actual volumes of suction that compressor efficiency is higher and approaches the isothermal value of unity. There are conditions where the exponent may be less as for example when the compressed volume is less than that of a perfect gas at corresponding temperatures and pressures. From the chart it will be noted that the γ values are low for the hydrocarbons included as components of natural gasoline. It is therefore practical and economical to compress the vapors from the stripping column before condensation, as the volumetric efficiency is high, the temperature rise small but positive, and the probabilities of condensation within the compressor negligible.

Iron Carbonyl *as an* Anti-Knock Compound

MICHAEL J. LEAHY
Consulting Engineer

A PECULIAR situation is fast developing in the matter of utilizing iron carbonyl as an anti-detonant in gasoline. A number of refiners—particularly those using zinc chloride and ammonia for gum removal—report that their fresh gasoline sometimes runs as high as 96 octane. The same gasoline in each case on standing, or after exposure to light, has an octane number of about 61. Some chemists have assumed that this reduction in octane number is due to the rapid formation of gums in these gasolines as all are off-color even after short exposure to sunlight.*

However, a number of chemists have come to the realization that such gasolines contain some iron carbonyl in solution and that this carbonyl precipitates rapidly on exposure to light. They are therefore now busily engaged in experimenting with processes for the production of iron carbonyl either separately or in the gasoline itself. Also, rather extensive experiments are being carried on in the search for a compound which may be added to iron carbonyl to render it insensitive to light. If iron carbonyl can be made insensitive to light, it would then be the ideal anti-detonant for gasoline as a very small amount—less than 0.1 percent by volume—raises the octane number by at least 35 integers; it is practically colorless in gasoline; it does not leave any harmful deposits in the combustion chamber of a motor; and it does not poison the skin of a person handling it in concentrated form.

In view of the above, it seems timely that a thorough analysis be made of the available literature pertaining to the production of iron carbonyl and of stabilizers therefor. In order to conduct such an analysis, a thorough search of the available technical literature on the subject and of United States and foreign patents relating thereto should be made. The author has endeavored to do this and presents a digest of his study with the hope that it will prove of benefit to the oil refining industry.

PHYSICAL AND CHEMICAL CHARACTERISTICS

Three iron carbonyls are known: Iron tetracarbonyl, $Fe(CO)_4$; iron pentacarboynl, $Fe(CO)_5$; and diferrononacarbonyl, $Fe_2(CO)_9$. Of these, iron pentacarbonyl is the most important anti-detonant. It was originally prepared by Mond, Langer and Quincke in 1890 by reducing ferrous oxalate with hydrogen and then treating the finely divided iron so formed with carbon monoxide gas. About one percent of the available iron was converted to iron pentacarbonyl which is a viscid yellow liquid that boils at 103°C. (217.4°F.)

The carbonyls are not acted upon by non-oxidizing acids but are rapidly decomposing by oxidizing acids and specially by aqueous solutions of the halogens (chlorine, iodine, bromine, etc.). They are all soluble in ether, ethyl alcohol, benzine, oils, etc., and insoluble in water. Vapors of the carbonyls are poisonous in that they are decomposed in the lungs with the evolution of carbon monoxide.

The iron carbonyls, especially the pentacarbonyl, are rapidly decomposed by light. This decomposition is most rapid in sunlight or blue light, and least of all in red light. When present even in minute quantities in gasoline, on exposure to sunlight iron carbonyl decomposes suddenly with the appearance of red-brown flocs. The detection of these flocs may be made more difficult by the presence of naphthenic acids or gum in the gasoline.

Iron carbonyls are also readily oxidized to ferric oxide on exposure to air. Hence concentrated solutions may explode spontaneously in air. If heated above 120°C. (248°F.) in air or oxygen, iron carbonyls explode with violence.

A simple qualitative test for iron carbonyl in gasoline is made by exposing a small amount of such gasoline to air on a thick filter paper. The filter paper is then treated with hydrochloric acid and potassium ferrocyanide. If iron carbonyl is present a blue coloration will appear.

Tests have shown that the addition of 3 c.c. of iron pentacarbonyl to one gallon of gasoline will raise

*Author's Note: Since the intent of this article is to be instructive rather than controversial, specific citations to the references tabulated are omitted in the body of the article.

the octane number of such gasoline from 58 to 96. It is absolutely necessary, however, that the iron carbonyl be not exposed to light or air either before, during, or after mixing with the gasoline.

METHOD OF MANUFACTURE

The original process for making iron carbonyl was to reduce compounds of iron, such as iron oxide, with hydrogen and then pass carbon monoxide over the reduced iron at temperatures greater than 120°C. (248°F.). The resulting vapors are condensed to form liquid iron carbonyl.

Since the above process was developed, patents have been granted on a multiplicity of variations on it and on processes which utilize roasted iron pyrites and water gas at pressures up to 200 atmospheres and temperatures up to 200°C. (392°F.); Swedish sponge iron and carbon monoxide; oxides of copper and iron reduced in hydrogen and then contacted with carbon monoxide; mixtures of iron oxide and alkali metals reduced and then contacted with carbon monoxide; iron oxides reduced with coal, semi-coke, oil shale, asphalt or petroleum residues and then contacted with water gas or pure carbon monoxide; metals suspended in liquids or melts such as petroleum oil, paraffin oil, molten paraffin, benzine, gasoline, etc., and contacted with carbon monoxide; roasted iron pyrites mixed with wood charcoal and reduced at 1000°C. (1832°F.) and then treated with carbon monoxide at 180 atmospheres and at 173°C. (343°F.) roasted iron pyrites reduced and then treated with a solution of carbon monoxide in liquid iron carbonyl at 175°C. (347°F.) and 280 atmospheres pressure; benzine saturated with carbon monoxide at 175°C. (347°F.) and then added to reduced iron pyrites; a mixture of iron oxide and liquid or solid hydrocarbons heated in a closed container, the carbon monoxide formed serving to form iron carbonyl from the iron so reduced; and several other processes which are obviously contrary to the laws of physics and chemistry and are therefore not listed.

STABILIZERS

Since iron carbonyl is so extremely photosensitive, it is not manufactured commercially. Consequently much research work is being done on the problem of finding compounds which, when mixed with iron carbonyl, will make it stable to light, either in concentrated form or when dissolved in gasoline.

The following stabilizers for iron carbonyl are cited in patents: Organic acids, esters, oxygen-containing organic compounds of high molecular weight, acetyl-acetone, 1, 4-diparatol - uenonanthroquinone, iron compounds of acetyl-acetone, azo dyes such as aminobenzine combined with ethyl-beta-naphthylamine, typophor black, adeps lanae, naphthenic acids, rubber, alpha-naphthalene-azo-alpha-naphthol, halogen-methanes, halogen-benzines, toluidine, methyl aniline, ethyl aniline, normal methylxylidine, ethylene chloride, chloroform, carbon tetrachloride, benzyl chloride, hexachlorbenzine, chloronaphthaline, ammonia halides and their organic derivatives such as methyl ammonium chloride, boric acid methyl or ethyl ester, tricresyl phosphate, zinc oleate, zinc isovalerate, chloral propionate, aluminum palmitate, calcium naphthenate, aromatic amines or their normal alkyl or normal aryl derivatives, secondary aliphatic amines containing up to three carbon atoms in the side chains, alcohols, dyes, aldehydes, ketones, stearic acid valeraldehyde, butyraldehyde, alizarin, or lanolin.

The author has produced—on a small laboratory scale—solutions of carbonyls which apparently are very insensitive to light. Exposure to direct sunlight for 23 days had no appreciable effect on these solutions even when in concentrated form. However, it is impossible to tell at this time the industrial potentialities of these new solutions; as no data are available on the cost of manufacture, their stability in air, or their physiological characteristics or reactions.

CONCLUSIONS

1. Iron carbonyl would be an efficient anti-detonant for gasoline if it could be made insensitive to light.

2. Although a large number of patents have been granted on various compounds which, it is claimed in each case, make iron carbonyl insensitive to light, apparently none are now in commercial use.

3. Refiners experimenting with the production or use of iron carbonyl in gasoline or stabilizers therefor, should have an exhaustive search made through the literature and patents pertinent to their prospective goal before spending much time and money developing processes which may later prove to be thoroughly protected by patents.

REFERENCES

Literature:

Journal of the Chemical Society. 1890, Vol. 57, pg. 749.

Chemical Society Transactions. 1891, pp. 604 and 1090.

Proceedings of the Royal Society. 1905, A76,588 and A79,56.

Trans. Faraday Society. 1922, Vol. 22, pg. 366.

Journal of the Chemical Society. 1922, Vol. 121, pp. 29-32.

Zeitschrift fur anorganische allgem. Chemie. 1924, Vol. 141, pp. 317-24.

La Revue des produits chimiques. 1926, Vol. 29, pp. 1-4.

Journal of The Chemical Society. 1927, pp. 3155-61.

La Revue des produits chimiques. 1927, Vol. 31, pp. 361-4.

La Revue univ. mines. 1927, pp. 145-6.

Journal Society of Chemical Industries. 1928, Vol. 47, pp. 311-2T.

Zeitschrift fur Elektrochemie und angewande physikalische Chemie. Vol. 320-3, 1928.

Berichte der deutschen chemischen Gesellschaft. 1929, Vol. 62B, pp. 2690-3.

Chemiker-Zeitung. 1929, Vol. 53, pp. 805-6.

Chemiker-Zeitung. 1929, Vol. 53, pp. 525-6.

Chimie et industrie. 1929, Vol. 21, pp. 681-700 and 937-40.

(Note: The above is an address by Robert L. Mond, who discovered iron carbonyls and contains references to 91 articles and 51 British, 3 Canadian, 4 French, 3 German, and 8 U. S. patents.)

Journal of Society of Chemical Industries. 1930, Vol. 49, pp. 271-8T, 283-4T and 287-90T.

Journal of Physical Chemistry. 1930, Vol. 34, pp. 1924-9.

Erdoel und Teer. 1932, Vol. 8, pp. 253-5.

(*Continued on next page*)

Zeitschrift fur physikalische Chemie. 1932, Vol. B18, pp. 219-40.
Zeitschrift fur anorganische allgem. Chemie. 1932, Vol. 204, pp. 145-83.
Petroleum Engineer, Sept., 1934. "Proficient Procedure in Handling Industrial Research Problems." Michael J. Leahy.

Patents:

(In the following list. I.G.F. is the abbreviation for I.G. Farbenindustrie Aktung-Gesellshaft, the German chemical trust. Also, U. S. Patents issued to Martin Muller-Conradi, A. Kossuth, Alwin Mittasch, Otto Ambros, and Carl Muller have been assigned to I.G.F.)

British No. 224,895, Nov. 26, 1924, Badische Anilin und Soda Fabrik.
German No. 499,296, Nov. 16, 1924. I.G.F.
German No. 518,387, Dec. 16, 1924. I.G.F.
German No. 539,759, Dec. 6, 1924. I.G.F.
British No. 248,683, Dec. 14, 1925. I.G.F.
British No. 250,132, Nov. 25, 1925. Badische Anilin und Soda Fabrik.
British No. 260,639, May 2, 1925. Badische Anilin und Soda Fabrik.
British No. 260,640, May 2, 1925. Badische Anilin und Soda Fabrik.
British No. 591,407, Nov. 13, 1925. Badische Anilin und Soda Fabrik.
German No. 485,886, Mar. 31, 1925. I.G.F.
German No. 491,431, April 5, 1925. I.G.F.
German No. 524,963, Mar. 31, 1925. I.G.F.
Canadian No. 262,600, July 13, 1926. M. Muller-Conradi & A. Kossuth.
Canadian No. 262,601, July 13, 1926. A. Mittasch & M. Muller-Conradi.
British No. 301,778, Sept. 5, 1927. I.G.F.
U. S. No. 1,614,625, Jan 18, 1927. M. Muller-Conradi.
British No. 301,778, Sept. 5, 1927. I.G.F.
British No. 301,099, June 25, 1927. I.G.F.
U. S. No. 1,679,256, July 31, 1928. Carl Muller, et al.
Canadian No. 284,972, Nov. 20, 1928. I.G.F.
French No. 652,594, April 12, 1928. I.G.F.
British No. 312,629, May 29, 1928. I.G.F.
British No. 319,356, Sept. 22, 1928. Vereinigte Stahl Werken Aktien-Gesellschaft.
French No. 674,458, May 2, 1928. I.G.F.
British No. 323,021, Aug. 18, 1928. I.G.F.
British No. 323,332, Nov. 30, 1928. I.G.F.
German No. 498,977, May 24, 1928. I.G.F.
German No. 512,223, April 8, 1928. I.G.F.
German No. 523,601, Aug. 7, 1928. I.G.F.
German No. 520,852, May 30, 1928. I.G.F.
German No. 518,781, July 6, 1928. I.G.F.
German No. 520,221, Oct. 25, 1928. I.G.F.
U. S. No. 1,722,076, July 23, 1929. Martin Muller-Conradi.
U. S. No. 1,725,619, Aug. 20, 1929. Martin Muller-Conradi.
French No. 674,216, April 29, 1929. I.G.F.
French No. 679,542, July 30, 1929. I.G.F.
French No. 681,988, Sept. 18, 1929. Vereinigte Stahl-Werke, A-G.
British No. 334,181, April 27, 1929. I.G. F.
French No. 677,548, June 28, 1929. I.G.F.
U. S. No. 1,759,268, May 20, 1930. Alwin Mittasch, et al.
U. S. No. 1,776,920, Sept. 30, 1930. Alwin Mittasch, et al.
U. S. No. 1,783,744, Dec 2, 1930 Alwin Mittasch, et al.
French No. 690,091, Feb. 17, 1930. I.G.F.
French No. 691,101 May 5, 1930. I.G.F.
German No. 547,024, April 8, 1930. I.G.F
German No 545,711, Feb. 5, 1930. I.G.F.
German No. 553,911, July 4, 1930. I.G.F.
German No. 553,920, Aug. 31, 1930. I.GF.
German No. 561,513, Nov. 21, 1930. Walter Heber.
U. S. No. 1,802,155, April 21, 1931. Martin Muller-Conradi, et al.
U. S. No. 1,816,122, July 28, 1931. Alwin Mittasch & C. Muller.
U. S. No. 1,828,376, Oct. 20, 1931. Martin Muller.
U. S. No. 1,891,203, Dec. 13, 1932. Otto Ambros, et al.
U. S. No. 1,868,044, July 19, 1932. Leopold Brandt.
British No. 370,962, April 8, 1932. I.G.F.
U. S. No. 1,924,453, Aug. 29, 1932. John E. Muth.
U. S. No. 1,893,021, Jan. 3, 1933. Phillip S. Danner.

Gum in Gasoline and the Automobile Engine

(*Continued from page 48*)

gasoline in large tanks will be far below the potential consumption for even a moderately stable gasoline. Thus the rate of gum formation, as long as the gasoline is undisturbed in the tank, will be a function of the oxygen supply rather than the stability.

Sullivan[9] states more or less arbitrarily that no excessive gum will form in storage for nine to 10 months, if the induction period is 3½ hours or more.

Flood and Edgar, Ethyl Gasoline Corporation, have made the following conclusions:

(1) No blend showing an induction period of four hours or more has formed appreciable gum in storage.

(2) Some gasolines show little gum formation after four months and high gum formation after eight months (corresponding to a short induction followed by a rapid pressure drop), while others have shown a fairly slow steady increase in gum, corresponding to a slow rate of pressure drop.

(3) All gasolines which have formed appreciable gum on storage have shown very short induction periods during oxidation, and much gum after oxidation.

Ethyl Gasoline Corporation considers stable a gasoline which shows no drop in pressure in four hours. A pressure drop in two hours or less indicates an unstable gasoline. Pressure drops between three and four pounds indicate a gasoline that may be unstable but not necessarily so.

Correlation is difficult between amounts of gum formed after oxidation and the induction period. Most samples showing no pressure drop at the end of four hours will show little gum (usually 5-25 mg.). Occasionally a sample will show no pressure drop, but will show 100 mg. of gum on evaporation.

A summary of the data indicates that an induction period of 240 minutes or a potential gum of 50 mg. or less indicates a gasoline that would be satisfactory in normal storage for periods less than one year.

[9] Oil & Gas Journal No. 43, 156, 1931.

World's *First* Duo-Sol Refinery uses CHAPMAN VALVES *Exclusively*

The Lummus Company has designed and built, under license of Max B. Miller and Co., Inc., the world's first commercial refinery to use the Duo-Sol process—the advanced method of extracting lubricating oil by using two immiscible solvents. For this new Socony Vacuum Oil Company plant which presents an entirely new set of operating conditions, the designers filled every valve requirement—exactly and economically—with Chapman Valves.

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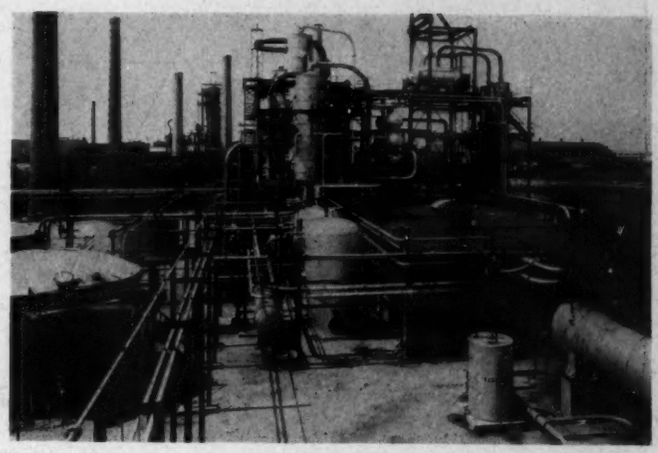

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NATIONAL SEAMLESS

PIERCED FROM SOLID BILLETS - NO WELDS

(*Continued from page 42*)

The importance of such hot oil was minimized by the fact that hot gasoline from East Texas continues confined almost wholly to the market outlet provided by tank trucks moving to points within the state. The significance of hot oil traffic was also lessened by the fact that state authorities have taken steps to further tighten up on regulation of truck movements.

Hot oil and refined products have continued to be virtually eliminated from railway tank car movement, interstate as well as intra-state. This control has existed despite the striking down of federal regulation of interstate oil shipment through the Supreme Court decision. It has been provided through the state's similar tender program. The State of Texas has recently obtained temporary restraining orders to prevent railroads from moving, interstate or intra-state, any oils not accompanied by clearance papers approved by the railroad commission. The courts and the railroads have thus been involved, along with the railroad commission, in keeping the big field under control.

A.P.I. to Meet In Los Angeles

EXECUTIVE officers of the American Petroleum Institute have selected November 11, 12, 13, and 14, 1935 as the dates for the organization's 16th annual meeting, to be held in the Biltmore Hotel at Los Angeles, California.

Sessions of the petroleum industry's largest national trade association will begin Monday, November 11, with committee meetings. The first general session will be held Tuesday, November 12, to be followed by the regular program of group sessions.

Los Angeles was selected for the 16th meeting by the board of directors in session at the 15th annual meeting in Dallas, last year. The executive officers were instructed to select the dates. The occasion will represent the second time an Institute annual meeting has been held on the Pacific Coast, with sixth annual meeting having convened in Los Angeles in 1925.

The Institute's mid-year meeting, largely a technical session, will be held this year at Tulsa, Oklahoma, on May 14, 15, and 16. In 1934 the mid-year meeting was held at Pittsburgh.

The Look Box

C. N. G. A. February Meeting

REVIEWING the latest methods in technical and engineering report writing as applied to petroleum operations, John F. Dodge, professor of Petroleum Engineering at the University of Southern California, addressed the February 7 meeting of the California Natural Gasoline Association.

Because of the steadily growing need for adequate training in statistical methods, Professor Dodge has given considerable study to the technique of writing technical and business reports for executives and engineers. He discussed the correct method of arranging material for presentation, methods of laying stress on essential facts, the preparation of graphs and charts, and methods of abstracting.

On the same program R. N. Donaldson, of the Research and Development Department of Standard Oil Company of California, described "A New Plant Residue Test," developed for the rapid determination of the "pentane plus" content of dry gas. The test is known as the butane absorption-weathering test. It can be conducted at a plant in about two hours time, and responds sharply to changes in operating conditions such as: changes in oil circulation, oil vapor pressure, etc.

Conventions

A. I. M. E. American Institute of Mining and Metallurgical Engineers, Petroleum Division, will hold its annual meeting in the Engineering Building, 29 West 39th Street, New York, on February 18, 19, 20 and 21.

I. M. I. S. On the last day, February 21 of the A. I. M. E. meeting will be a joint symposium on the use of metals in the petroleum industry held in conjunction with the Institute of Metals, Iron and Steel.

W. P. R. A. The Western Petroleum Refiners Association on April 4 and 5 will hold its annual meeting at Excelsior Springs, Mo., at the Elms Hotel.

A. C. S. Beginning April 22, American Chemical Society will hold its semi-annual meeting in New York City.

N. G. A. May 1, 2, 3, Natural Gasoline Association of America will hold its annual meeting at the Tulsa Hotel, Tulsa, Oklahoma.

A. I. C. E. May 14-16, American Institute of Chemical Engineers will meet for its semi-annual convention in Wilmington, Delaware.

A. P. I. American Petroleum Institute will hold its fifth mid-year meeting in the Mayo Hotel, in Tulsa, May 14, 15, 16.

P. G. C. O. A. Pennsylvania Grade Crude Oil Association plans to hold its annual convention at State College, Pennsylvania, June 20 and 21.

A. S. T. M. American Society for Testing Materials annual meeting is scheduled for June 24 to 28 at the Book Cadillac Hotel, Detroit, Michigan.

A. P. I. The American Petroleum Institute will hold its 16th annual meeting at the Biltmore Hotel, Los Angeles, November 11-14.

A. I. M. M. E. Program

AN interesting program of technical papers is scheduled in the program of the American Institute of Mining and Metallurgical Engineers for its fourteenth regular meeting to be held in the Engineering Societies Building, New York, February 18 to 21. Of particular interest to the refining industry are the meetings of the A. I. M. M. E. Division of Petroleum, and the Institute of Metals, Iron and Steel, in two joint sessions Thursday, February 21. At this time the following papers are to be presented:

"The Corrosion Problem," by J. E. Pollock.

"Heat Resisting Alloys," by W. F. Furman.

"Refinery Pumps," by A. E. Harnsberger.

"Heat Exchangers and Condensers," by H. L. Bedell.

"Development in Pipe and Tube Products," by E. C. Wright.

"Sucker Rods," by B. B. Wescott.

A.P.I. Mid-Year Meeting Plans

TENTATIVE plans for the fifth mid-year meeting of the American Petroleum Institute, scheduled for May 14 to 16 in the Mayo Hotel at Tulsa, Oklahoma, confine the program largely to divisional group sessions and committee meetings.

Since the mid-year meeting is held to permit discussion of subjects largely technical in character, it is possible that no general session will be held.

The tentative program follows:

Tuesday, May 14—Morning and afternoon—committee meetings. Evening—general committees of the divisions.

Wednesday, May 15—Morning—Board of directors. Divisional group sessions. Afternoon—Divisional group sessions.

Thursday, May 16—Morning and afternoon—divisional group sessions.

Favorable Statistical Position Attained in 1934

THE statistics of the petroleum industry for 1934, featured in this issue, are predominantly favorable, and they offer encouragement that 1935 will be similarly or more satisfactory.

Demand for oils continued during 1934 on the upward trend that was resumed in the latter portion of 1933, reflecting the general progress out of the depression. Along with the favorable demand situation went, moreover, a good situation with regard to balancing supply with the demand, the output of crude oil and also of refined products having been held in restraint during 1934 to such extent as to bring about important reductions of stocks.

The restraint practiced at wells and refineries promoted favorable markets, and generally satisfactory prices, coupled with increased volume of business, resulted in the highest earnings in the industry since 1930.

Crude oil prices remained constant during the year at levels profitable to the producers, and the producing branch of the industry enjoyed especially satisfactory results. Refinery prices were at considerably depressed levels during several periods of the year, due largely to production and refining of hot oil, and the refining branch of the industry was consequently at a disadvantage. Service station prices were abnormally low for several months early in the year on the Pacific Coast, and in the Mid-Continent and East a similar period late in the year, with price wars resulting from influx of hot gasoline and from controversy between major and independent companies over differentials between their postings. But aside from those limited periods, retail prices were generally satisfactory, and the marketing branch of the industry fared accordingly.

Highest Demand for Four Years

Total demand for United States petroleum in 1934 is indicated to have been the highest since 1930. Bureau of Mines figures are not yet available covering December. But for the first 11 months of 1934, the total demand for all United States oils aggregated 945,785,000 barrels. Corresponding 11-months' figures for earlier years included 892,321,000 barrels in 1933; 863,646,000 barrels in 1932; 946,786,000 barrels in 1931; 977,109,000 barrels in 1930. While the 11 months demand for 1934 was slightly lower than in 1931, the full 12 months' figure for 1934 will apparently be greater than the full 1934 total. (In November, 1934, the total demand was 89,863,000 barrels; in November, 1931, with demand on the decline, it was 80,038,000 barrels).

The large increase of 53,464,000 barrels, or approximately 6 percent, in the 1934 11-months' demand figure over the previous year resulted primarily from a sharp expansion of domestic consumption, although there was also some increase in export business, involving both crude and refined oils. (Crude oil exports in the 1934 period rose to 38,691,000 barrels from 33,948,000 barrels in 1933, and refined oil exports to 67,186,000 barrels from 64,190,000 barrels).

The total of domestic demand for all oils for the 11 months of 1934 was 839,908,000 barrels, compared with 794,183,000 barrels in 1933, an increase of 45,725,000 barrels, or 5.7 percent. Conspicuous in the breakdown of the domestic demand by products, was an increase, greater than the average, for motor fuel, the industry's leading product and revenue-producing item. The domestic demand for motor fuel in the 11 months was 375,752,000 barrels, compared with 348,431,000 barrels in 1933, an increase of 7.8 percent.

There were also important increases in domestic consumption of most of the other refined products. Kerosene demand in the 11 months of 1934 aggregated 39,209,000 barrels, compared with 34,333,000 barrels in 1933. Gas oil and fuel oil demand rose to 298,098,000 barrels, from 285,385,000 barrels; lubricants to 17,094,000 barrels from 15,507,000 barrels; asphalt to 12,447,000 barrels from 11,047,000 barrels; road oil to 7,711,000 barrels from 5,036,000 barrels. The exceptional products, which met with lower demand in 1934 included wax, which for the 11 months had demand of 795,000 barrels, compared with 1,145,000 barrels in 1933; coke, down to 6,863,000 barrels from 9,177,000; and still gas, down to 40,573,000 barrels from 41,655,000 barrels.

Sources of Supply Under Control

In meeting the higher demand for oils in 1934, there was close balancing of supply against the demand, effective control having been exercised over the three sources of supply: domestic production, imports, and storage. Both domestic production and imports were higher than in 1933, but they were sufficiently low, nevertheless, to fall under requirements; and in fulfilling the total demand, large draughts were made upon the stocks of both crude and refined oils.

United States crude oil production in 1934 was about 4,400,000 barrels higher than in 1933 and the highest on record except the 1929 output. The 1934 total is indicated to have been approximately 910,051,000 barrels, using official Bureau of Mines figures for the first 11 months of the year and estimating December with the aid of American Petroleum Institute weekly reports. This figure compares as follows with Bureau of Mines totals for earlier years:

United States Production

Year	Barrels
1926	766,504,000
1927	901,129,000
1928	901,474,000
1929	1,007,323,000
1930	898,011,000
1931	851,081,000
1932	785,159,000
1933	905,656,000
1934 (preliminary)	910,051,000

In its weekly estimates of production, the American Petroleum Institute has not attempted to include oil which may have been surreptitiously produced. Statistics compiled with those

Stocks on Hand at End of Year

(Barrels)

Year	[1]Crude Oil	Fuel Oil	[2]Motor Fuel	Miscellaneous	[3]Total
1927	.....	.....	.....	.....	597,143,000
1928	.....	.....	.....	.....	619,725,000
1929	.....	.....	.....	.....	689,166,000
1930	411,882,000	.....	.....	.....	666,662,000
1931	370,919,000	135,856,000	56,171,000	58,727,000	621,673,000
1932	339,715,000	129,881,000	53,805,000	66,705,000	590,106,000
1933	355,312,000	123,500,000	55,933,000	68,462,000	603,207,000
1934[4]	340,000,000	110,000,000	50,000,000	66,000,000	566,000,000

[1]Exclusive of California heavy crude. [2]Exclusive of unfinished gasoline. [3]Total not classified prior to 1931, as classifications before that year were on different basis, and are consequently not comparable. [4]December changes estimated, latest official figures being as of December 1. Figures prior to 1934 are as reported by U. S. Bureau of Mines.

A 5-month plan

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What part of that gallonage will be yours—and at what price?

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reports as the basis indicate, consequently, production of only 880,335,812 barrels in 1934. The difference between the two sets of figures indicates that at least 30,000,000 barrels of oil was produced surreptitiously or clandestinely during the year, about the same as in 1933, a high proportion of such output for both years having been from the East Texas field. (The Bureau of Mines basis indicated about 181,183,000 barrels production for East Texas in 1934; the A.P.I. basis, 158,370,100 barrels). It should be noted, in this connection, that the A.P.I. omits only underhand production, covering which weekly reports or reliable estimates are not available.

While United States crude petroleum production was slightly higher in 1934 than in 1933, domestic output of natural gasoline and benzol also increased. In the first 11 months of 1934, the natural gasoline production aggregated 32,981,000 barrels, compared with 30,789,000 barrels in the corresponding 1933 period. Benzol production meanwhile increased to 1,477,000 barrels from 1,248,000 barrels.

Imports Slightly Higher

Increases in imports for 1934 were relatively small. During the first 11 months, crude oil imports aggregated 30,404,000 barrels, compared with 29,017,000 barrels in the 11 months of 1933. Refined products imports amounted to 13,691,000 barrels, against 12,659,000 barrels. Corresponding Bureau of Mines figures on imports during December, 1934, are not yet available. But American Petroleum Institute weekly reports on imports indicate that total imports, not separated as to crude and refined oils, aggregated 4,173,000 barrels in December, 1934. When that A.P.I. figure is added to the Bureau of Mines figure for the first 11 months, it is indicated that total imports of all oils into the United States in 1934 aggregated 48,268,000 barrels, or averaged 132,241 barrels daily. In 1933 the imports had totaled 45,394,000 barrels, or 124,367 barrels daily.

In the following table are presented figures on imports in earlier years:

Imports of Oil Into the United States

Year	Bbls. Crude	Bbls. Refined	Bbls. Total
1927	58,383,000	13,353,000	71,736,000
1928	79,767,000	11,790,000	91,557,000
1929	78,933,000	29,777,000	108,710,000
1930	62,129,000	43,489,000	105,618,000
1931	47,250,000	38,837,000	86,087,000
1932	44,682,000	29,812,000	74,494,000
1933	31,893,000	13,501,000	45,394,000
1934 (Preliminary)			48,268,000

Gasoline Production Allocation for February

THE allowed production of gasoline by refinery districts (including the production of straight run and cracked gasoline and the natural gasoline blended therewith, either at refineries or terminals) has been determined, in accordance with Section 3, Article IV of the Code to be, for the month of February, 1935, as follows:

Ditsrict	Allocation to Meet Current Demand Barrels	Allocation for Seasonal Stock Increase Barrels
1. East Coast	3,977,000	1,239,000
2. Appalachian	1,235,000	219,000
3. Indiana-Illinois-Kentucky	4,180,000	916,000
4. Oklahoma-Kansas-Missouri	4,041,000	583,000
5. Texas:		
(a) Inland Texas	1,814,000	100,000
(b) Texas Gulf Coast	5,813,000	688,000
(c) East Texas	449,000	None
6. Louisiana-Arkansas:		
(a) Louisiana Gulf Coast including Alabama	982,000	328,000
(b) North Louisiana-Arkansas including Mississippi	673,000	10,000
7. Rocky Mountain	512,000	155,000
8. California	4,284,000	362,000
	27,960,000	4,600,000
Total United States	32,560,000 barrels	

Patent Litigation Decision Rendered

JUDGE SAM G. BRATTON, United States Circuit Court, Tenth Circuit, Albuquerque, New Mexico, in his decision January 16 stated that Champlin Refining Company, Enid, Oklahoma, in its operation of the Winkler-Koch cracking process does not infringe on patents of Rosenbaum, No. 1,324,983; Cross No. 1,734,079, and Howard and Loomis No. 1,869,337, as alleged by Gasoline Products Company in its suit against the refining company. The court held that the Rosenbaum patent is a paper patent, the teachings of which have made no impression on the art and should be strictly construed when it is attempted to read its claimed on a present day commercial operation, and is invalid for lack of utility. The process disclosed by this patent and that used by the defendant are not substantial equivalents, but differ in substantial respects and therefore there is no infringement. If the Rosenbaum patent be construed in such manner as to cover the defendants process, it is invalid because it is anticipated by by disclosures of prior art.

"The Cross patent in the suit," the decision reads, "is invalid because the disclosures made are more obvious details of engineering construction and the elements of the claims are anticipated by the prior art. Accordingly, there is no infringement.

"As process disclosed by the Howard and Loomis patent in suit and that employed by the defendant do not accomplish substantially the same thing in substantially the same manner, but are different in substantial respects, there is no infringement. But if the patent be construed in such manner as to cover the defendant's process, it is invalid because anticipated by the disclosures of prior art."

Crude Production Allowable Increased

AN increase of 65,800 barrels daily in the national allowable crude oil production was authorized for February by Oil Administrator Harold L. Ickes. February's daily production was placed at 2,526,100, as compared with 2,460,300 barrels daily authorized for January.

The Bureau of Mines and the Petroleum Administrative Board, in recommending the allowable to Administrator Ickes under the terms of the Oil Code, set forth that the increase would be necessary to meet preparations of the industry for the opening of the spring trade season.

The largest increase was authorized for Texas, a jump of 24,900 barrels to 1,031,700. Other allowables follow:

Arkansas, up 1000 to 32,000; California, up 14,700 to 488,600; Colorado, unchanged at 3500; Illinois, unchanged at 11,700; Indiana, unchanged at 2200; Kansas, up 1500 to 138,600; Kentucky, up 800 to 14,800; Louisiana, up 9800 to 109,500; Michigan, up 1900 to 30,000; Montana, up 200 to 9500; New Mexico, down 400 to 49,400; New York, up 300 to 10,300; Ohio, unchanged at 11,700; Oklahoma, up 7800 to 497,100; Pennsylvania, up 3500 to 39,000; West Virginia, unchanged at 11,000; and Wyoming, down 200 to 35,500.

Gasoline Taxes In 1934

U. S. MOTORISTS paid more in gasoline taxes during 1934 than was paid in federal tobacco, liquor, dividends and excess profits taxes combined, current estimates of the year's gasoline taxes indicate.

According to calculations of the American Petroleum Industries Committee, the state and federal gasoline tax bill paid by highway users in 1934 amounted to approximately $730,000,000, plus an estimated $10,000,000 in liquid fuels taxes collected in Ohio in addition to the gasoline tax, making the total motor fuel bill $740,000,000.

This compares with collections of $736,939,967 reported by the Bureau of Internal Revenue from the federal

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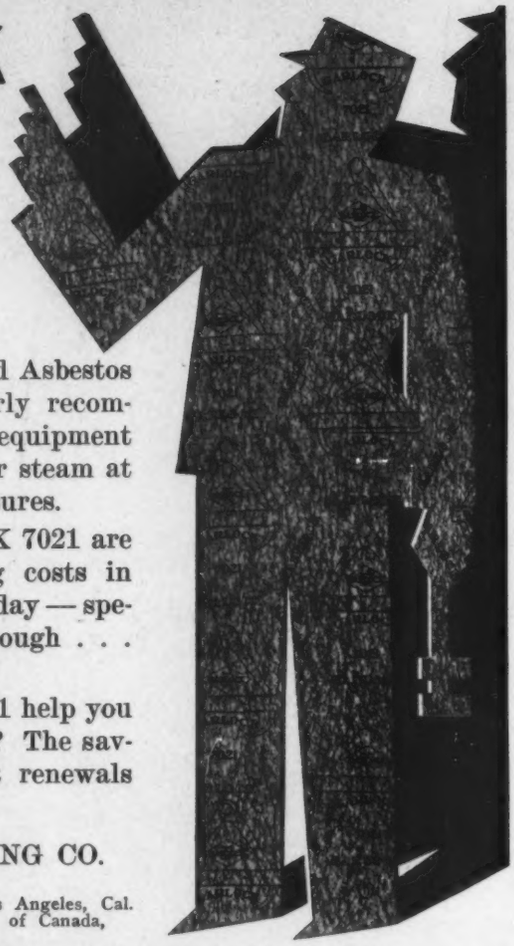

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levies on tobacco, liquor, dividends and excess profits during the last fiscal year.

Motor fuel tax collections by the states during the year were placed at $570,000,000 by the committee, an increase of approximately $52,000,000 over the previous year's collections of $518,195,712. Despite a reduction of ½ cent per gallon in the federal gasoline tax, revenue from this levy declined only $11,000,000.

Two states, Texas and Arkansas, which have increased their enforcement and collection efforts particularly during the past year showed large gains in collections. The gain in Texas amounted to more than $4,000,000, or an increase of 14.5 percent, while the gain in Arkansas amounted to 17.7 percent. Only part of the gain in Arkansas is attributable to improved collection methods, however, since the rate in the state was increased ½ cent per gallon during the year.

Sales Tax on Gasoline Average 38 Percent

STATE and federal gasoline taxes in 1934 represented an average retail sales tax of 38.12 percent, a recent study of prices and taxes in 50 cities made by the American Petroleum Industries Committee has shown.

Gasoline prices throughout the year averaged 13.64 cents per gallon, while state and federal taxes averaged 5.2 cents. The average cost of gasoline (price plus tax) was 18.8 cents per gallon.

The highest average retail price reported during the year was 14.31 cents per gallon on June 1, while the lowest was 11.72 cents per gallon on November 1. The highest cost was 19.52 cents per gallon, also on June 1, and the lowest 16.93 cents on November 1.

First reports of gasoline prices and taxes in 1935 revealed the average retail price on January 1 as 12.78 cents per gallon, the average tax as 5.22 cents and the average cost as 18 cents.

C. N. G. A. Sampling Bulletin

BRINGING up to date the latest information on the sampling of natural gas and gasoline, the California Natural Gasoline Association has issued Bulletin TS 342, which supplants an earlier bulletin published in 1932 (TS-322). The product of the cooperative efforts of a committee headed by H. J. Multer of Union Oil Company, this document should find a wide use.

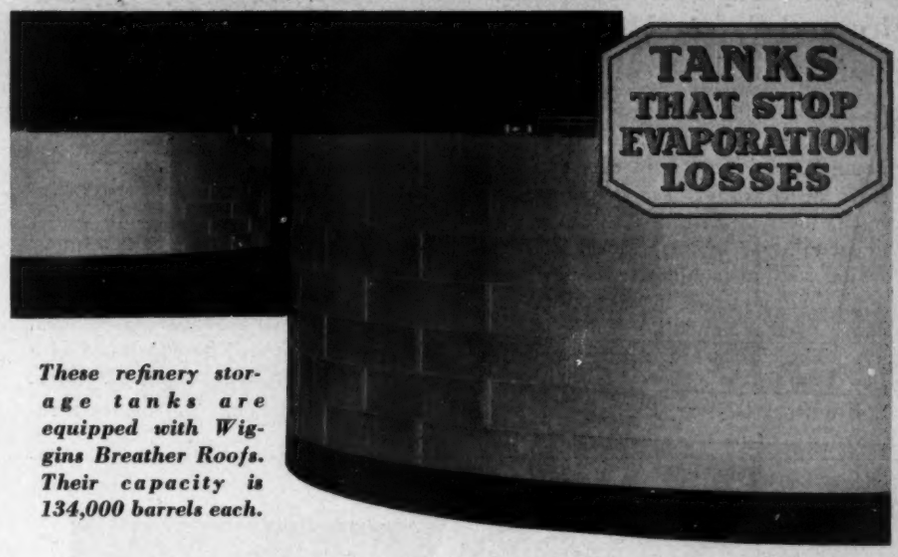
Describing in detail the technique to

be followed, and precautions to be observed in sampling gases and liquids, the 13-page bulletin deals specifically with such items as the design of proper containers, preparation of the containers for sampling, and gives methods to be followed in obtaining good samples. The section on gas sampling is expanded to include developments in the use of the center-line sampling tap with illustrations for its construction and installation.

The bulletin concludes with hints on the sampling of liquefied petroleum gas and recommendations for obtaining proper gas and gasoline samples at absorption plants. Copies can be obtained through the C. N. G. A. Secretary, 1217 Associated Realty Building, 510 West Sixth Street, Los Angeles, 25 cents postpaid.

Second Edition Chemical Formulary

THE Chemical Formulary, Volume 2, just published is an enlargement and revision of Volume 1 completed and distributed, a year or so ago. H. Bennet is editor in chief and the number of contributing editors and consultants has been increased from 56 to 109. There are over 500 pages of formulas selected by this group of chemical experts. In addition there is a subject and detailed index which is of real help in using this reference work. Of real advantage is the fact that the formulas presented on these thousands of items are all new and up-to-date. There are hundreds of formulas for new products. The Formulary enjoys the distinction of being the only book of its kind insofar as its scope and thoroughness is concerned. In addition to formulas of general nature there are the following chapters which will prove of commercial and industrial value: Animal preparations (dips, sprays and the like); cleaners and soaps; coatings, protective and decorative; cosmetics; emulsions, fuels, glass, ceramics, inks, insecticides, insulation and electrical specialties, materials of construction, metals and alloys, plastics, platings, polishes, abrasives, etc.; resins, and gums, and numerous others. In so far as possible the authors have striven not only to give the formula but accompanying that in the text with instructions for processing, compounding, and the like. Copies of Volume 2 of The Chemical Formulary can be secured through the Gulf Publishing Company, Book Department, P. O. Box 2811, Houston, Texas. Price $6.00.



These refinery storage tanks are equipped with Wiggins Breather Roofs. Their capacity is 134,000 barrels each.

Saving 248 bbls. of Crude Oil per month in one tank

AN oil company wanted to determine the evaporation loss of crude oil in standing storage due to breathing, caused by temperature changes within the vapor space. In order to do this, identical records were kept for 71 days on two new 118,000 bbl. tanks, one with a cone roof and one with a Wiggins Breather Roof. The seriousness of this loss and the value of using Breather roofs to stop it are clearly indicated in the following data.

Two 144 ft. diameter refinery storage tanks were used. They were both filled to the same gauge with East Texas crude. Losses were measured by gauging and also by the Whitman vapor pressure method, samples being tested by the Miner Laboratories, Chicago. The tank with the Breather roof was gauged both in the gauge hatch and the sample hatch. These points are diametrically opposite, eliminating error in gauging due to settling in the tank.

The loss in the Breather tank by the gauging method was 47 bbls., while the Whitman method showed a slight gain. In the cone roof tank the loss by gauging was 500 bbls., and by the Whitman method 768 bbls. The average of the losses by the two methods shows a saving in favor of the Wiggins Breather Roof of 248 bbls. per month on a full tank. This saving would pay for the difference between the cost of a Breather roof and a cone roof in 2.7 months or for converting a cone roof to a Breather roof in 14.1 months.

This illustration is typical of savings which can be effected by specialized equipment. Our experience in the field of evaporation engineering is available without cost or obligation.

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Tulsa	1626 Thompson Bldg.	Philadelphia	1608-"1700" Walnut Street Bldg.
Birmingham	1548 Fiftieth St., N.	Boston	1529 Consolidated Gas Bldg.
Chicago	2463 Old Colony Bldg.	San Francisco	1051 Rialto Bldg.
Detroit	1520 Lafayette Bldg.	Los Angeles	1334 Wm. Fox Bldg.

Plants in Chicago, Birmingham, and Greenville, Pa.

Fire and Safety Marshals Semi-Annual Meeting

THE semi-annual meeting of the Fire and Safety Marshal's National Petroleum Association, held early in December at Bradford, Pennsylvania, reports an attendance that was the greatest ever enjoyed by such meetings. The morning session inaugurated a new feature, the competitive inspection of the refinery of the Kendall Refining Company. The following groups participated:

1. Bradford, Bolivar, Eldred, Farmers Valley, Wellsville. 2. Oil City, Titusville, Franklin, Emlenton, Butler, Bruin, Karns City, Petrolia. 3. Warren, North Warren, Clarendon. 4. Pittsburgh. The first prize was won by the inspecting group representing Oil City, etc.

As the result of the competitive inspection, the Kendall Refining Company received the benefit of a number of constructive suggestions all designed to avoid fires and accidents. The competitive inspection aroused a great deal of interest and it will be continued as a feature of other semi-annual meetings.

Following luncheon, the meeting resolved itself into a round table discussion of the following matters:

"Plans for Fire Prevention," led by D. V. Stroop, American Petroleum Institute.

"Proper Method of Running Foam Lines to a Tank," led by S. M. Wolbert, Kendall Refining Company.

"Proper Method of Running Fire Steam Lines to a Tank," led by C. H. Lindberg, Conewango Refining Company, with a paper by W. L. Gettings, Conewango Refining Company.

"Precautions to be Taken Against Electrical Hazards in a Refinery," led by D. J. Harvey, The Pennzoil Company.

The annual meeting of the Fire and Safety Marshals will be held at Oil City in June and a similarly fine program is being arranged for this meeting.

Haylett Chairman Technology Committee

R. E. HAYLETT, Union Oil Company, Los Angeles, has been appointed chairman of the American Petroleum Institute's Central Committee on Refinery Technology for 1935, W. G. Skelly, chairman of the General Committee of the Division of Refining, has announced. R. P. Anderson has been reappointed secretary.

Other members of the committee include: D. G. Brandt, Henry L. Doherty & Company, New York; H. W. Camp, Empire Oil & Refining Company, Tulsa; T. G. Delbridge, The Atlantic Refining Company, Philadelphia; R. A. Halloran, Standard Oil Company of California, San Francisco; E. W. Isom, Sinclair Refining Company, New York; Emby Kaye, Skelly Oil Company, Tulsa; E. R. Lederer, Texas Pacific Coal and Oil Company, Fort Worth; N. E. Loomis, Standard Oil Company of New Jersey, New York.

K. G. Mackenzie, The Texas Company, New York; Walter Miller, Continental Oil Company, Ponca City; John Newton, Magnolia Petroleum Company, Beaumont; G. G. Oberfell, Phillips Petroleum Company, Bartlesville; R. C. Osterstrom, The Pure Oil Company, Chicago; L. W. Parsons, Tide Water Oil Company, New York; A. E. Pew, Jr., Sun Oil Company, Philadelphia; J. B. Rather, Socony-Vacuum Oil Company, New York; H. G. Smith, Gulf Refining Company, Philadelphia; F. W. Sullivan, Jr., Standard Oil Company (Indiana), Chicago; F. W. L. Tydeman, Shell Development Company, San Francisco; and H. D. Wilde, Jr., Humble Oil & Refining Company. Houston.

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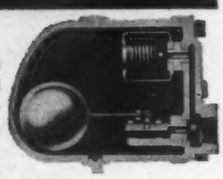

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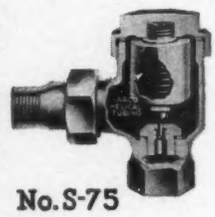

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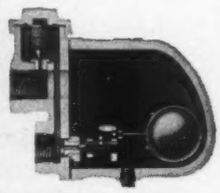

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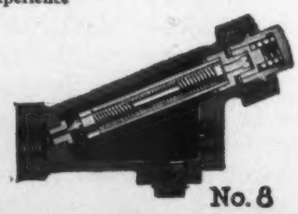

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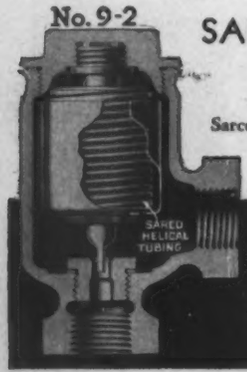

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SARCO STEAM TRAPS

Index to A.S.T.M Standards and Tentative Standards

THE Index to American Society for Testing Materials Standards and Tentative Standards, just published, is designed to be of service in determining whether the A.S.T.M. has issued any specifications or test method, on particular materials or subjects in the materials field. Since the total number of A.S.T.M. standards and tentative standard is some 730, the Index is a decided convenience in this respect and also very helpful to those interested in the materials field, such as purchasing agents, engineers, architects and others, in locating any of the items in the publications where they appear.

All of the A.S.T.M. specifications and tests are listed in the current Index, under appropriate key words and the items under a particular subject are arranged alphabetically according to the significant word in the title, thus facilitating use of the Index. A list in numeric sequence of the serial designations is also included. Copies of this publication, aggregating 142 pages, are furnished without charge to those who send requests to the American Society for Testing Materials headquarters at 260 South Broad Street, Philadelphia.

Bell Establishes Engineering Service in Italy

COMPAGNIA Tecnica Industrie Petroli has been organized with headquarters at Milan for the sale, engineering service, and manufacture of equipment which will be needed in the contemplated expansion of the Italian oil industry. This company is acting as sales and manufacturing agents for various American manufacturers and for American processes. Among the companies that it will represent are:

Max B. Miller & Company, for Duo Sol and contact filtration plants; the Oil Conservation Engineering Company, for the line of Oceco specialties; The Girdler Corporation, for the selective gas absorption processes; C. H. Leach Company, for all types of high and low pressure heat exchangers. The company will also act as sales agents and distributors for Oil Well Supply Company for drilling machineryy and production equipment. It is contemplated that other lines of noncompeting equipment may be added from time to time.

The formation of this company will offer to the oil companies engaged in the construction or installation of equipment in Italy the advantage of being able to buy American equipment made within the country. Italian regulations are very specific to the effect that there will be no imports of equipment or material that can be furnished by the Italian manufacturers.

H. S. Bell of New York, consultant on

DEGREES & DOLLARS

AND LOW POUR-TEST OILS

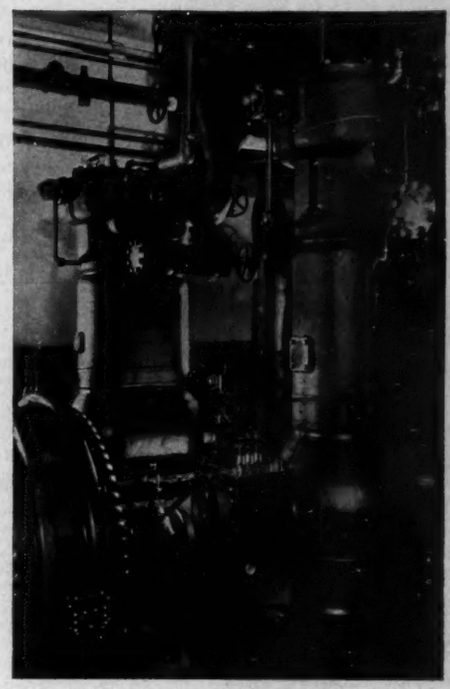
● Oil temperatures as low as minus 60 degrees F... a saving of from 15 to 25% in horsepower... accomplished with York Booster Compression and the York Patented Liquid Recirculating System in the production of low pour-test oils.

● York Booster Compression offers a maximum of flexibility and economy to compression plants with two temperature loads. It permits lower temperatures in the absorption plant which may be limited in that respect by existing water temperatures.

● The York Patented Ammonia Recirculating System eliminates static pressure. Each stage operates at the highest pressure possible for the desired temperature. Each square foot of evaporating surface is kept uniformly wetted with liquid ammonia and its efficiency is maintained by constant elimination of any oil carried over from the compression side.

● It will pay you to ask for a copy of York Booster Compressor Bulletin 32164 at the nearest of York's 71 direct factory branches.

York Ice Machinery Corporation, York Pa.



The York Booster Compressor is of the semi-enclosed type and is equipped with special cylinder lubrication control which is essential to low temperature refrigeration. No matter what combination of two temperature loads is encountered, York Booster Compression can be adapted to provide maximum flexibility and minimum power requirements.

YORK REFRIGERATION

ABSORPTION & COMPRESSION

Efficient applications for all types of solvent processing

Pioneers lead the way to prosperity

Cracking Units produce high-quality distillates most economically, efficiently and safely when lime, of the proper quality, is added to the charging stock entering the still. Our 24-page booklet "Pioneer Lime—A Contribution to Oil Refining Efficiency" explains how lime functions to prevent corrosion; facilitate coke removal, and promote "B. S." separation, and why **Pioneer Oyster-Shell Lime** is especially adapted to these operations. A copy is yours on request.

THE HADEN LIME COMPANY

MFRS. OF PIONEER OYSTER SHELL LIME

1720 SHEPHERD STREET

HOUSTON-TEXAS

Smooth, Responsive Wide Speed-Range Drives For Hot or Cold Oil Pumps

Latest Troy-Engberg Vertical Steam Engine, Type E, showing modern variable eccentric which cuts steam consumption by 15%. Sizes up to 450 H.P.

Within the past few months, the following companies bought Troy-Engberg Steam Engines, vertical or horizontal, for driving pumps:

Union Oil Company
Standard of California
Shell Petroleum Corporation
Louisville Refining Company

These modern steam engines provide certain operating characteristics that make them ideal for driving much of the refining equipment; for example: flexibility with maintained efficiency over a wide speed range; smooth transmission of power; quick response to automatic control; will more than match any pump's service life and keep it on stream; high starting torque.

Investigate fully these modern steam engines for driving not only pumps but other equipment.

TROY ENGINE & MACHINE CO.
933 RAILROAD AVENUE, TROY, PENNA.

T R O Y - E N G B E R G

Horizontal and Vertical Steam Engines—A. C. & D. C. Generating Sets

ROTO TUBE CLEANERS

built for Oil Still Tubes, 3" I.D. *and up*

Roto Special 6-way Drill Head and Universal Joint.

Roto Combination Head and Universal Joint.

THE ROTO COMPANY

Sussex Avenue and Newark St., Newark, N. J.

petroleum engineering problems, will make his headquarters in Italy and act as technical advisor to the new company. Mr. Bell's services as consultant will be available also to any of the oil companies in Italy. The office of H. S. Bell, Inc., 233 Broadway, New York, will remain open to continue his American practice. Associated with the new project will be Comm. Ing. Giorgio Varvaro. Comm. Varvaro was for several years Italian representative of the American banking firm of Field-Glore & Company and is an engineer of broad experience in the public utility and industrial field in Italy.

Russia to Become Great Consumer of Petroleum

DESPITE disparagment of its efforts from certain quarters, Russia appears in full stride toward the goal of becoming one of the largest consumers of petroleum products in the world, if one may believe recently published statements concerning progress of the various industries there.

Gains in industrial production, pig iron output, coal production, automobile output, electric power output, freight shipments, construction, and factory employment were registered in 1934 by Russia, according to a chart appearing in "Business Week," which stated Russia had shown, and is showing, a tremendous capacity to absorb raw and finished materials even though it has suffered somewhat in export business as have other countries.

The trend of all the above activities is at present upward, and it is illogical to presume road building, facilitation of transportation, and use of prime movers depending upon petroleum products for fuel will not be in the same direction, whether those products be for consumption in government owned or privately owned conveyances.

Alcohol Blend Would Increase Gasoline Costs

MOTORISTS would be compelled by law to use a blend of alcohol and gasoline in their automobiles and trucks if a bill introduced by Congressman John T. Buckbee, of Illinois, is passed by Congress.

The measure would make it unlawful for any person to sell motor fuel in the United States unless it is blended with at least 10 percent of alcohol made from corn or other American farm products, or unless a tax of 10 cents per gallon is paid. This 10-cent tax would be in addition to the gasoline taxes, averaging five cents per gallon, already imposed by the states and the federal government.

It is estimated that with corn at present prices, the cost of the blended fuel would be five cents a gallon higher than straight gasoline. The higher price would increase motor fuel costs approximately $30 per vehicle annually.

A similar measure was recently defeated in Canada, while protests by motorists regarding alcohol blends have resulted in the repeal of such a law in Brazil. Although alcohol blend measures have been introduced in each of the last few sessions of Congress, no action has been taken. Alcohol blends, introduced into several European countries as a measure of national defense, are also reported to be working unsatisfactorily, while all tests conducted in this country by impartial agencies have proved the impracticability of the scheme.

Opposition to the bill has already developed on the part of motorists, truck operators, farmers, oil dealers, automobile clubs and automotive engineers. Those opposed to the bill state that impartial tests have shown: 1. That motoring costs, already high, will be raised another $30 a year for each vehicle. 2. That financial benefit to farmers is questionable, while a blended fuel will increase the cost of operating farm trucks and tractors. 3. That while the "real" price of corn today is higher than normal, the price of petroleum products is 50 percent below normal. That the penalizing of one domestic industry to subsidize another is unjust and discriminatory. 4. That a blend would increase motor fuel consumption by four percent. 5. That engine starting would become more difficult, and operating difficulties would result from the separation of the blend in the presence of moisture.

Oil States' Governors Honorary Members A.P.I.

GOVERNORS of the 22 oil-producing states have been invited to become honorary members of the American Petroleum Institute.

The invitation was extended by President Axtell J. Byles in accordance with a decision reached by the board of directors that the governors of states in which oil is produced should have an opportunity to participate in discussions of the board and to learn of the many factors influencing trends in the petroleum industry. It was explained that the honorary memberships were created for the governors largely for the purpose of permitting a more general understanding of the industry and its problems.

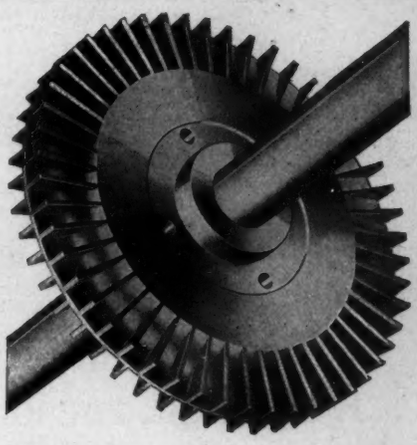
Until the present there has been only one honorary member of the Institute. He is Mark L. Requa, of San Francisco, federal oil administrator during the World War. The position permits attendance at board meetings and participation in discussions, but grants no voting power.

The invitations already have gone forward to the governors of these states:

Arkansas, California, Colorado, Illinois, Indiana, Kansas, Kentucky, Louisiana, Michigan, Mississippi, Missouri, Montana, New Mexico, New York, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, Utah, West Virginia, and Wyoming.

A FURTHER step in the consolidation of operations of Socony-Vacuum Oil Company, Inc., was recently announced. Three refining and marketing subsidiaries of the company, White Star Refining Company of Detroit, Michigan, Lubrite Refining Company of St. Louis, Missouri, and White Eagle Oil Company, a Kansas organization, will in the future operate under the name of the parent company. Each will retain its former identity in that each will be a division headquarters to be known as the White Eagle, White Star and Lubrite divisions. There now remain three important subsidiaries not having the name of the parent company;

Westco's only moving part. This turbine-type Impeller enables Westco to produce multi-stage performance in only single-stage construction. →



How to SAVE MONEY On Corrosion-Resisting Pumps

Small metal requirements and simple design of Westco Turbine Pumps provide answer to this live problem.

WESTCO Turbine Pumps are economically constructed from corrosion-resisting alloys because:

1. *With only ONE Impeller, Westco's re-energizing pump action produces pressures, which in many cases are as high as those produced by conventional centrifugal pumps using 3 and 4 Impellers.*
2. *Ordinary cast iron or acid-resisting bronze casings may often be used with complete satisfaction and additional savings. This is possible by using alloy Liners and Impeller where velocity of liquid is greatest and corrosion most rapid.*

Improved Westco Propane and Reflux Pump

Just announced is this new Westco unit with extra deep, lubricated stuffing boxes, over-size ball bearings and extra heavy shaft. Pump mounting allows full play to expansion and contraction. Built in sizes from 5 to 200 G.P.M. against pressures up to 300 lbs.

Will Not Vapor Bind

Westcos efficiently handle light, volatile gasoline, propane, etc., of 100° to 130° A.P.I. gravity because they operate against pressures up to 300 lbs. per square inch *without vapor binding.*

Furthermore, these modern pumps supply an ideal, non-pulsating feed to high pressure stabilizers which increases the efficiency of the columns by eliminating overload and underload of the stabilizer trays. Westcos are favorites throughout the industry for Still Charging and for handling Hot Oil, Fuller's Earth, Chlorine Treating Solutions, Mineral Seal Oils, Naphtha, Brine, Water, etc.

Send Coupon for Details

Send coupon below for FREE interesting Catalog containing handy Performance and Selection Tables. No obligation. WESTCO PUMP CORPORATION, Davenport, Iowa. Branches: New York, Phila., Chicago, Los Angeles and San Francisco. Representatives in 50 Principal Cities.

COUPON BRINGS DETAILS

WESTCO PUMP CORPORATION, Davenport, Iowa, Dept. N-2. *Gentlemen: Without cost or obligation, please send me your Catalog of Westco Turbine Pumps for Refinery and Natural Gasoline Plant duties.*

Name .....

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State .....

WESTCO *TURBINE* PUMPS

HIGH PRESSURE - - - SINGLE STAGE

these are Magnolia Petroleum Company in the Mid-Continent; Bartles-Maguire Oil Company, Milwaukee and Chicago, and General Petroleum Corporation on the West Coast.

R. W. CRANFIELD is in charge of operations at Agua Dulce, Texas, for Nueces Refining Company at its 20,000-gallon gasoline plant and skimming type refinery. Matson Nixon, Southern Alkali Company, Corpus Christi, Texas, has been appointed receiver for the company. D. A. Price is chief chemist.

FRED GEIGER is superintendent of refinery at Mirando City, Texas, for Amsco Refining Company. The plant has a capacity of 3000 barrels skimming and 1200 barrels cracking. K. W. Bartlett is president and J. A. Bartlett is chief chemist.

A. H. MYERS, formerly with Texas Mexican Refining Company, Laredo, Texas, is in charge of manufacture of lubricants for Rado Producing & Refining Company, McAllen, Texas. Walter K. Campbell is president of the company.

Facts about

The Refiner

1. Editorially, THE REFINER is devoted entirely to the Manufacturing Division of the Oil Industry. It is a specialized paper for men in a specialized field.

2. More men in the Refining business are regular subscribers to THE REFINER than any other paper. It is First Choice among a majority of the Industry's leaders throughout the world.

3. THE REFINER carries more refinery equipment and service advertising than any other paper. Many of these advertisers use THE REFINER exclusively among oil papers. It is the market-place for refinery equipment.

Renew your subscription promptly.

The Refiner—*First in its Field*

Lederer Chairman of Labor Sub-Committee

THE Planning and Coordination Committee announces the appointment of Dr. E. R. Lederer as chairman of the Labor Sub-Committee to replace H. H. Anderson, who resigned several weeks ago to return to Shell Oil Company office in St. Louis.

DR. E. R. LEDERER

Dr. Lederer has been connected with the petroleum industry for many years as a refining engineer and is vice president in charge of refining of Texas Pacific Coal & Oil Company. He has taken an active part in the operation of the program and refining committees.

As chairman of the Labor Sub-Committee, he devotes his full time beginning Monday, January 28.

DR. D. P. BARNARD, assistant director of research, Standard Oil Company (Indiana), Whiting, was elected a vice president of the Society of Automotive Engineers, representing fuels and lubricants, at the recent meeting in Detroit. Dr. Barnard succeeds A. Ludlow Clayden, Sun Oil Company, whose term in the same office expired with this meeting.

H. W. JACKSON, Kendall Refining Company, Bradford, Pennsylvania, has been appointed a member of the American Petroleum Institute committee on accident prevention..

G. M. FITCH, formerly with Shell Oil Company, now is general manager of Sterling Refining Company, and in charge of refinery operations. Plant is located in the Bandini-Telegraph district, Los Angeles.

DR. J. BENNETT HIGH, formerly chief chemist, The Atlantic Refining Company, has resigned to become director of research for Sun Oil Company, Philadelphia.

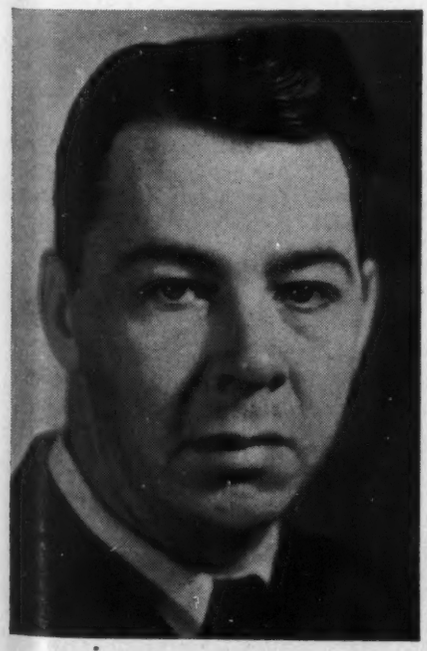
C. R. McGINNIS is operating Valley Refining Company's pipe still type skimming plant at Harlingen, Texas.

RALPH S. WYRICK is in charge of Garland Clymore's Clymore Company, Inc., natural gasoline plant and The Refugio Refinery at Refugio, Texas. W. R. Hounsell is chief chemist and assistant superintendent.

J. F. WHITEHURST is in charge of the new plant of Corpus Christi Refining Company, near Corpus Christi and adjacent to Southern Alkali Company's new chemical plant. Geo. Whitner is chief chemist and B. H. Perkins is chief engineer.

L. R. WAGSTAFF, formerly with Nueces Refining Company, Agua Dulce, Texas, is in charge of The Alice Refining Company's recently completed skimming plant at Alice, Texas. G. P. Shelton is manager and part owner with Emmert & Emmert.

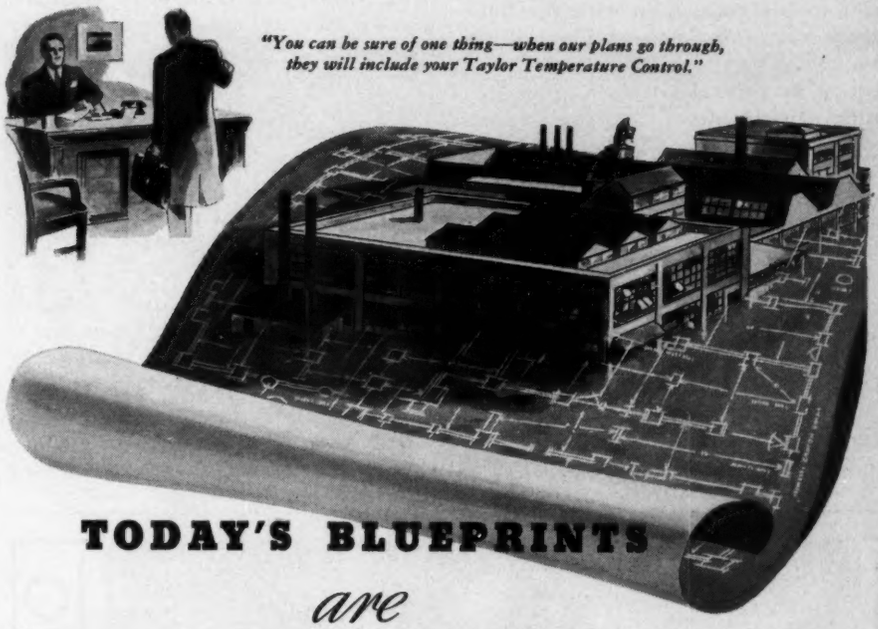
THE Walworth Company, 60 East Forty-Second Street, New York, has announced the appointment of E. L. Clark as manager of its Houston office, 1117 Second National Bank Building. Mr. Clark started with the company in 1930, and since that time has spent 2½ years in the East Texas field and about two years in the Southwest Texas territory.



E. L. CLARK

WALTER SAMANS, chief engineer, The Atlantic Refining Company and A. J. Ely, engineering department, Standard Oil Development Company, have recently been appointed to the Boiler Code Committee of the American Society of Mechanical Engineers. Both men are members of the American Petroleum Institute's Sub-Committee on Unfired Pressure Vessels and of the Joint API-ASME Committee on Unfired Pressure Vessels. Mr. Samans is chairman of both committees. The joint committee recently completed a code for unfired pressure vessels now in wide use by the industry.

C. M. JOHNSON, consulting petroleum engineer, Houston, specializing in refinery design, operation and management, is now associated with Suburban Fuel Oil Service, Inc., of Mt. Vernon, New York, and is in charge of that company's manufacturing operations and purchasing, in its recently opened Houston office. The company and its associated companies, Suburban Petroleum Products, Inc., and Petro-



"You can be sure of one thing—when our plans go through, they will include your Taylor Temperature Control."

TODAY'S BLUEPRINTS

are

TOMORROW'S PLANTS

Will they provide for the most efficient and economical temperature control? Let us help you plan for it NOW.

HERE'S an actual case of far-seeing management. A superintendent already has plans on paper to improve the physical layout of his plant. He has decided on needed modern equipment, including Taylor Temperature Control. He is looking ahead to assure higher and more uniform product quality, greater operating efficiency and lower costs. When economic conditions permit, he is ready to turn blueprints into physical assets.

Wherever exact control of temperature is essential (and that includes practically every industry), Taylor Instruments are operating accurately and efficiently to assure uniform high-quality production at lower cost. These results are known to the petroleum industry through use of Taylor Recorders and Controllers in essential operations in leading oil refineries. Taylor Control saves money and begins to pay dividends quickly, for they usually pay for themselves in a year's time.

Here is the one basic reason for all this: A Taylor Control consists of a specially engineered, unified system of accurate, durable indicating, recording and controlling instruments, built to fit a plant's special needs and installed under strict supervision.

Look into Taylor Control Now

It is sound management today to investigate every possible method for making your plant an even more efficiently operating unit. Find out just what Taylor Control can do for you—on temperature, pressure or flow.

Let a Taylor man survey your present set-up now, even though economic conditions may delay putting more extensive control into operation. Then you'll be ready to profit from it quickly at the right moment. For this help, address the Taylor Sales Offices in Atlanta, Boston, or Toronto, Canada. Or write Taylor Instrument Companies, Rochester, N. Y.

Taylor

Indicating Recording • Controlling

TEMPERATURE, PRESSURE *and* FLOW INSTRUMENTS

leum Storage Corporation, deals in heating oils, selling direct to consumers in the New York markets with company-owned trucks. The New York terminals at Rye, Mt. Vernon and Brooklyn, are supplied with kerosene and various grades of heating oils by a chartered tank steamer operating out of the Port of Houston on regular schedule.

A large refinery on the Houston ship channel is now operating under contract for account of Suburban Fuel Oil Service, Inc., and a second plant operation will be added soon. Mr. Johnson, prior to his association with the Suburban group, was in general consulting practice in Houston, following his connection as general manager of the refining department of the Crown Oil & Refining Company. Earlier work included positions as designing engineer for Pierce Petroleum Corporation, chief engineer for Invincible Oil Corporation, chief engineer and partner in the Williams Petroleum Engineering Company, and designing engineering for Empire Gas & Fuel Company. Johnson is a graduate of the California School of Mechanical Arts and member of the American Society of Mechanical Engineers and associate member of the United States Naval Institute.

▼ PLANT ACTIVITIES ▼

Cracking: The Arend Petroleum Company, subsidiary of Canadian Eagle Oil Company, of the Shell group, at Aruba, Dutch West Indies, 20,000 barrel topping plant, is erecting cracking facilities and has placed order with A. O. Smith Corporation for 10 additional oil cracking vessels ranging from four to seven feet in diameter and from 16 to 63 feet in length.

Negotitions: Tide Water Oil Company, New York, is reported negotiating for the refining, producing and transporting properties of Simms Oil Company. Simms has shut down refineries at Dallas, Texas, and Smackover, Arkansas.

Move: Los Fresnos Refining Company, Los Fresnos, Texas, owning a small lubricating oil plant, is reported planning to move equipment to Matamoros, Mexico.

Additions: Corpus Christi Refining Company, Corpus Christi, Texas, operating a 1000-barrel cracking plant, is reported contemplating addition of a gasoline recovery system and stabilizer.

Operating: The Alice Refining Company, Alice, Texas, recently completed by Emmert & Emmert, is operating its Tulsa Type topping plant on light crudes from nearby producing areas.

Move: Phillips Petroleum Company, following sale of its gas contracts and gathering system at Homer, Louisiana, to Arkansas Natural Gas Corporation, plans to move its 10,000-gallon natural gasoline plant from that area to Oklahoma.

Improvements: Standard Oil Company of New Jersey, 30 Rockefeller Plaza, New York, is planning to spend between $50,000,000 and $56,000,000 for improvements and additions to facilities in the United States in 1935, and about $17,000,000 on steel pipe, machinery and other construction materials to be sent abroad. Crude oil production and pipe line plans involve about $36,000,000. Refining and marketing facilities around $15,000,000 to $20,000,000.

Liquefied Gas: International Petroleum Company, installing a plant for production of liquefied petroleum gases in the Talara oil fields, Peru, South America, expects to complete the unit late in February. Pacific Gas Company, S.A., Lima, Peru, will secure fuel from the new plant for bottled gas distribution around March 1, according to C. E. Guyant, manager of the company.

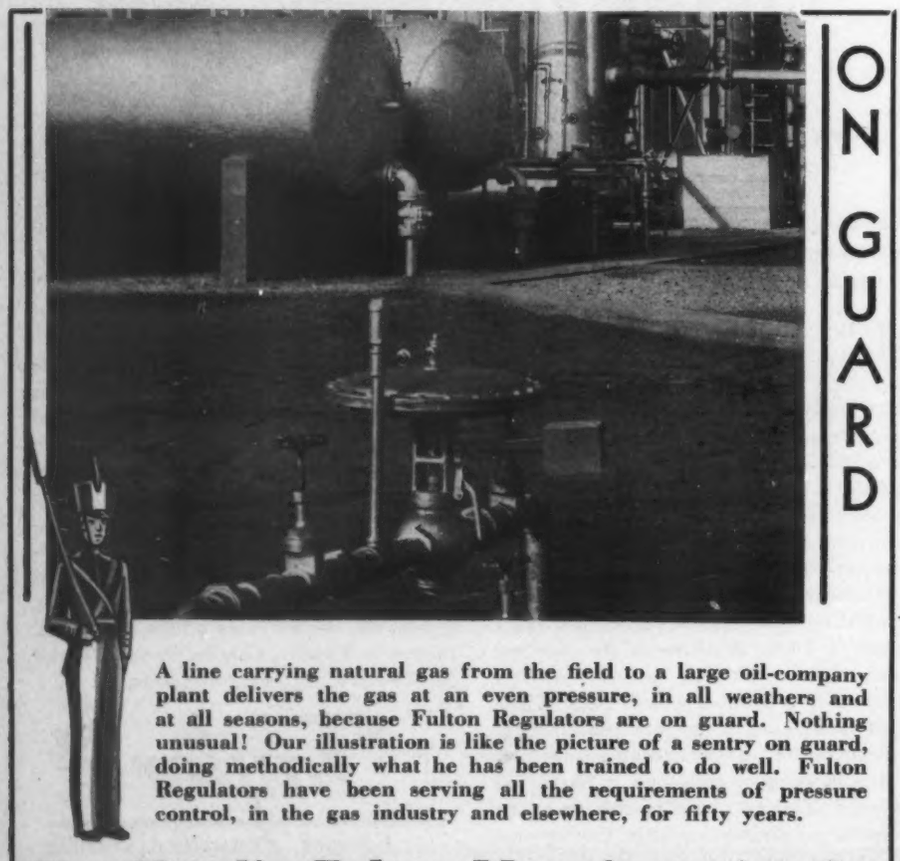
Solvent Plant: Freedom Oil Works, Freedom, Pennsylvania, has let contract to Leader Industries, Inc., for construction of a new Chlorex solvent extraction unit to process 500 barrels of bright stock or 1200 barrels of neutrals daily. Construction to start at once. A pipe heater and vaporizer tower will be included in the design.

Cracking Plant: Freedom Oil Works, Freedom, Pennsylvania, has let contract to Leader Industries, Inc., for construction of a 500-barrel Dubbs cracking unit to be full flashing type, equipped with bubble tower and side cut stripper, new type heater and other modern accessories.

Power Plant: Crown Central Petroleum Corporation, Houston, has let contract to Henry Vogt Company for a new bent tube water tube boiler with fusion welded drums and design for maximum capacity of 75,000 pounds of steam per hour. Normal rating 750 horsepower.

Refinery: St. Lawrence Oil, Ltd., Pointe aux Trembles, Quebec, Canada, is reported planning to erect a refinery and 15 gasoline stations. Reported cost $750,000.

Purchase: E. F. Jones, Chase, Kansas, independent oil operator, has purchased the Chase refinery from Secur-



A line carrying natural gas from the field to a large oil-company plant delivers the gas at an even pressure, in all weathers and at all seasons, because Fulton Regulators are on guard. Nothing unusual! Our illustration is like the picture of a sentry on guard, doing methodically what he has been trained to do well. Fulton Regulators have been serving all the requirements of pressure control, in the gas industry and elsewhere, for fifty years.

The Chaplin-Fulton Manufacturing Co.

28-40 Penn Avenue **Pittsburgh, Pa.**

ity Petroleum Company of Kansas City. Plant was sold under a trusteeship arrangement in a bankruptcy proceeding. Jones' bid was $6300. The new owner did not announce when operations would be resumed.

Dismantling: Star Refining Company, Kilgore; O. K. Refining Company, Kilgore; Calcul Refining Company, Gladewater; Texas Petroleum Products Company, Somerset, and Los Fresnos Refining Company, Los Fresnos, all in East Texas, have dismantled their refineries. Texas Pacific Coal & Oil Company will dismantle or sell its refinery at Wynnewood, Oklahoma.

Refinery: Seal Beach Refining Company, seal Beach, California, is building a 750-barrel skimming plant to be in operation early in February.

Refinery: Harry Brown, Hynes, California, is building a new refinery north of the Long Beach producing area to be completed about March 1.

Refinery: Bellview Oil Company, Santa Fe Springs, California, has repaired damage following fire at its recently erected skimming plant and is again operating.

Remodeled: Sterling Refining Company, which took over the Atlas Lubricating Oil Company plant in the Bandini-Telegraph district, Los Angeles, has completely remodeled the plant and is now operating. G. M. Fitch, formerly with Shell Oil Company, is general manager and in charge of the plant.

Terminal: General American Tank Storage & Terminal Company at Houston has acquired a 50-acre site on the Houston Ship Channel and is starting construction of a large tank farm and loading terminal with plans for completion in April. Initial tank capacity 500,000 barrels.

Liquefied Gas: Gas Oil Products, Inc., Philadelphia, is building a liquid gas plant at Lucinda, Pennsylvania, using a high pressure fractionating system supplied with artificial refrigeration. Contract to Burrell-Mase Engineering Company.

Gasoline Plant: Fred Bowen is reported building a new East Texas natural gasoline plant on the Willis Smith farm, J. S. Carruthers Survey, Gregg County, Texas.

Refinery: Bay Refining Company, Bay City, Michigan, is building a 350-barrel skimming plant on the Marston farm, Bangor Township. Arthur Tonkin, president. Crude from properties of W. J. Sovereign, a director.

Solvent Plants: Shell Petroleum Corporation at Wood River, Illinois, is progressing rapidly in erection of its new Duo-Sol solvent extraction plant, under arrangement with The Max B. Miller Company, and The Lummus Company. At the same plant the company is erecting a propane solvent dewaxing plant of 2500 barrels reported capacity.

Solvent Plant: Standard Oil Company of California at its Richmond plant has completed erection of its new solvent extraction plant to use analine oil, phenol and other solvents.

Solvent Plant: Standard Oil Company (Indiana) is completing erection of a new propane solvent dewaxing plant of 1200 barrels capacity at Wood River, Illinois.

Solvent Plant: The Atlantic Refining Company, Philadelphia, has completed construction of its new 1000-barrel nitrobenzine solvent extraction plant.

Gasoline Plant: Sunray Oil Company, near Sunray, Texas Panhandle, early in January completed construction of its new natural gasoline plant on the Moore farm.

Stabilizer: Sunray Oil Company, at its Allen, Oklahoma, refinery, late in January completed construction of a new gasoline recovery plant and stabilizing system.

"Well, You Wouldn't Buy a Weak Heart, Would You?"

"You're no earthly use when your heart stops pumping and a refinery is just as dead when its pumps stop. While a fellow can't pick his own heart he'd be dumb to buy a weak one for a refinery!"

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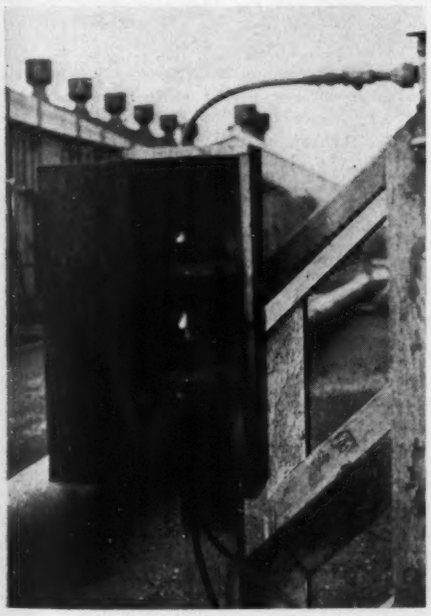
Ideas

THE following items are typical of those desired by THE REFINER for publication in this department. Where original, such items will be paid for at the usual space rates. Contributions will be welcome and should be accompanied by a photograph or drawing of such nature that others in the industry will find it easy to use such ideas or methods in the event they fit their needs.

Water Chlorinator

TO prevent excessive amounts of chlorine being placed in the water circulated over the louvre tower, a simple and inexpensive apparatus can be installed. One is in use in a gasoline plant in Southern California and through its use the proper amount of chlorine can be introduced in the water that will effectually prevent the growth of algae.



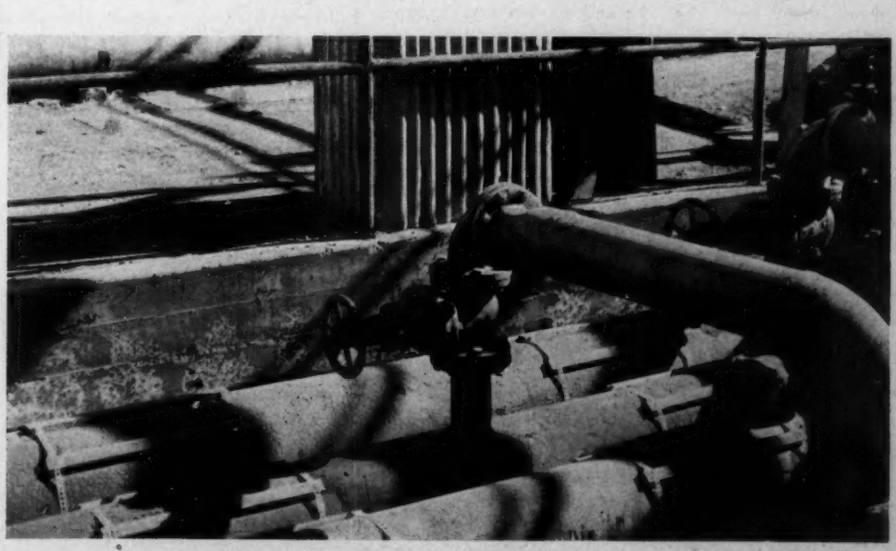
Water Chlorinator

The cylinder of liquid chlorine is placed in a small shed nearby with adequate piping leading from it to the control valve placed at a convenient position beside the sight feed apparatus. Chemical tubing is used to transfer the chlorine from the control valve to the unit, and tubing is used to convey the water in which the chlorine is dissolved to the louvre tower pit.

By analysis of the water to determine the suitable chlorine content at regular intervals, the amount introduced to the louvre tower pit can be easily adjusted to provide the desired concentration to retard and prevent plant growth, but to prevent a saturation sufficient that will cause corrosion of metals. The apparatus is simply a glass receptacle in which three holes are placed. The upper hole receives the tubing carrying the chlorine. There are two holes in the base. One of these is used to introduce the line carrying water, and through the other the overflow leaves the mixer.

Skid Preventer

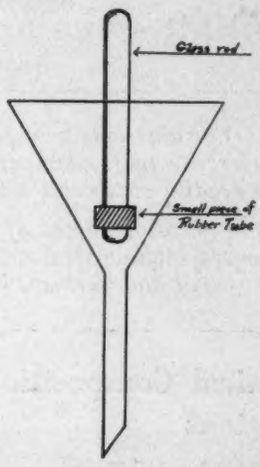
WHERE open pipe trenches are in use operators are sometimes injured because of their tendency to step rather carelessly when adjusting gates and other equipment. To prevent slipping at such points one plant operator places an inexpensive apparatus on the piping near the valves to protect the men, especially at night, when visibility may be poor. These steps are made from strips of light wood, tied together at the ends with strap metal in sections long enough to be fastened around the pipe. Each location on the plant where it is necessary for men to step across the pipe is protected with these slip or skid preventers. The cost is nominal, but the results are positive. These slip preventers are not intended to displace the usual grated walks across the pipe trench but to supplement them. Where gates, stops, controls or other similar equipment are at points where it is impractical to cover them with grating such devices are of value.



Skid Preventer

Measuring Liquids With High Viscosity

IN our laboratory we make frequent analysis of fuel oils; part of the procedure being to centrifuge exactly 50 c.c. of oil.



In transferring the thick oil to the graduated centrifuge tube, it was found to be almost impossible to get the exact quantity, besides usually making a great deal of mess in the process.

To overcome this the simple apparatus in the accompanying sketch was devised. The glass rod is just small enough to fit inside the stem of the funnel; and the washer is merely a short piece of rubber tubing, with a diameter small enough to fit tightly over the rod.

In use, when the required quantity of oil has been run into the centrifuge tube, the glass rod with rubber tip is pushed into the stem of the funnel, thus stopping the flow.

J. H. M. Taylor, Powell River, B. C., in "The Chemist Aanlyst," Jan. 1935.

SCIENCE AND TECHNOLOGY

Abstracts prepared in co-operation with the

REFINER AND NATURAL GASOLINE MANUFACTURER

by

THE LESLIE LABORATORIES

Traver Road, Ann Arbor, Mich.

under the supervision of

DR. E. H. LESLIE and DR. H. B. COATS

The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstract, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Chemical Composition and Reactions

Deuterium Content of Natural Butane. R. D. Snow and Herrick L. Johnston. *Science,* **80** (1934), No. 2070.

Butane from a Burbank natural gas condensate contained 30% more deuterium than is found in ordinary hydrogen. This agrees almost exactly with the amount found by Dole in Oklahoma kerosene and in northern Pennsylvania natural gas by Greene and Voskuyl. Deuterium was determined by burning the butane from a quartz jet in the absence of air with Linde tank oxygen. The combustion gases passed through a tube containing copper oxide at 900° C. Two samples of the condensed steam were collected and purified three times by distillation, the first from potassium permanganate and the second from caustic potash. An 80% heart cut was collected from each distillation. The deuterium content of the final water was determined with the buoyancy balance according to the method of Lewis and MacDonald.

Isomerization of Normal Butanes. V. N. Ipatieff, H. Pines and R. E. Schaad. *Jour. Am. Chem. Soc.* **56** (1934), pp. 2696-8.

The rearrangement of normal butenes in the presence of catalysts has not been studied quantitatively heretofore. The authors find that the isomerization of 1- into 2-butene was slight in the presence of phosphoric acid at room temperature, but increased with rising temperature. A similar increase in isomerization with temperature rise was observed when 1-butene was treated under pressure in the presence of diatomaceous earth impregnated with phosphoric acid. At 249°C. the isomerization was complete under 7.8 atmospheres of pressure. Pure trans-2-butene underwent partial isomerization into 1-butene and cis-2-butene during passage through 100% orthophosphoric acid at 100°C. 1-Butene isomerized partially into 2-isomer in the presence of perchloric acid and aqueous solutions of zinc chloride and benzene solfonic acid.

The Nitrogen Compounds in Petroleum Distillates. VIII. Degradation of the Naphthenic Base C_{16} $H_{25}N$ to the Lower Homolog $C_{15}H_{21}N$. R. W. Lackey and J. R. Bailey. *Jour. Am. Chem. Soc.* **56** (1934), pp. 2741-3.

The bromination of the $C_{16}H_{25}N$ naphthenic base from the kerosene distillate of California petroleum is described. The unexpected resemblance of this non-aromatic base to 2, 4-dimethyl-quinoline in its reaction with formaldehyde proves the presence of two methyls through oxidation of the addition product to a dicarboxylic acid and subsequent decarboxylation of the latter to a monocarboxylic acid and then to a $C_{14}H_{21}N$ base. From these reactions, the structural possibilities for the 16-carbon base are restricted to trinuclear doubly-bridged ring systems. A provisional formula is advanced in which two methyls occupy the same relative positions to nitrogen as the two methyls in 2, 4-dimethylquinoline. In other respects, the structure is little changed from the pyrindacine formula previously proposed.

The Thermal Decomposition of Organic Compounds from the Standpoint of Free Radicals. XII. The Decomposition of Methane. F. O. Rice and M. D. Dooley. *Jour. Am. Chem. Soc.* **56** (1934), pp. 2747-9.

When methane is decomposed thermally in a flowing system, methyl groups escape from the furnace and can be identified as dimethyl ditelluride. No telluroformaldehyde is formed, which proves the absence of methylene radicals in the gases leaving the furnace. Furthermore, no hydrides of tellurium were found in the liquid air trap, which indicates the absence of atomic hydrogen from the gaseous fragments leaving the furnace. The authors state that their experiments indicate that methane undergoes a primary dissociation into methyl groups and atomic hydrogen. The atmic hydrogen disappears before reaching the mirror, either on the walls or by reaction with methane to form methyl radicals and molecular hydrogen. The activation energy of the primary process is 100 ± 6 Cal.

Ignition Temperatures of Gases: Experiments of (the late) H. B. Dixon. H. F. Coward. *Jour. Chem. Soc.* (1934), 1382-1406.

The work of Dixon, including a detailed description of his apparatus for determination of the ignition temperatures of gases, together with many of his experimental results, is discussed by the author. Ignition points for the following, under various conditions, were determined by Dixon: hydrogen in air or oxygen, hydrogen in nitrous oxide, carbon monoxide with and without hydrogen in air, methane in air. The hydrocarbons studied included methane, ethane, pentane, benzene, ethylene, propylene and acetylene, mixed with air or oxygen. The effects of small amounts of added gases were studied, as well as the inhibiting effects of iodine and other organic halogen compounds. The author discussed Dixon's work and compares it with that of other workers.

The Action of Silent Electric Discharge on Hydrocarbon Gases and Oils. A. W. Nash, J. L. Howard and F. C. Hall. *Jour. Inst. Pet. Tech.* **20** (1934), pp. 1027-43.

The author's note that there has been considerable interest in the subject of the action of the silent electric discharge on oils, particularly in connection with the modification of the properties of lubricating oils. The article discusses the scientific aspects of this subject and reviews the published accounts of experimental work bearing on the subject that hitherto have been scattered and somewhat difficult of access. The action of the silent discharge on paraffins, olefins, acetylenes and cyclic hydrocarbons is described, as well as the action of the silent discharge on fatty acids and oils. The production of lubricating oils by the Electrion and Voltol processes is reviewed and the properties of these oils given. The use of the silent discharge in connection with vapor-phase cracking is briefly discussed. A bibliography of 131 references is appended.

Manufacture: Processes and Plant

Effect of Entrainment on Plate Efficiency in Rectification. F. H. Rhodes. *Ind. & Eng. Chem.* **26** (1934), pp. 1333-5.

The author notes that the number of equilibrium units required to effect a given separation in a rectifying column can be calculated by various methods. One of the factors in reducing the plate efficiency of working columns is entrainment. However, no equation has been developed quantitatively to correlate the amount of entrainment and its effects upon plate efficiency. Such an equation is developed by the author and the method is applied both to rectifying and exhausting column calculations.

Heat Transmission Through Bare and Insulated Furnace Walls. R. H. Heilman. *Chem. & Met. Eng.* **41** (1934), pp. 637-41.

The author discusses heat transmission

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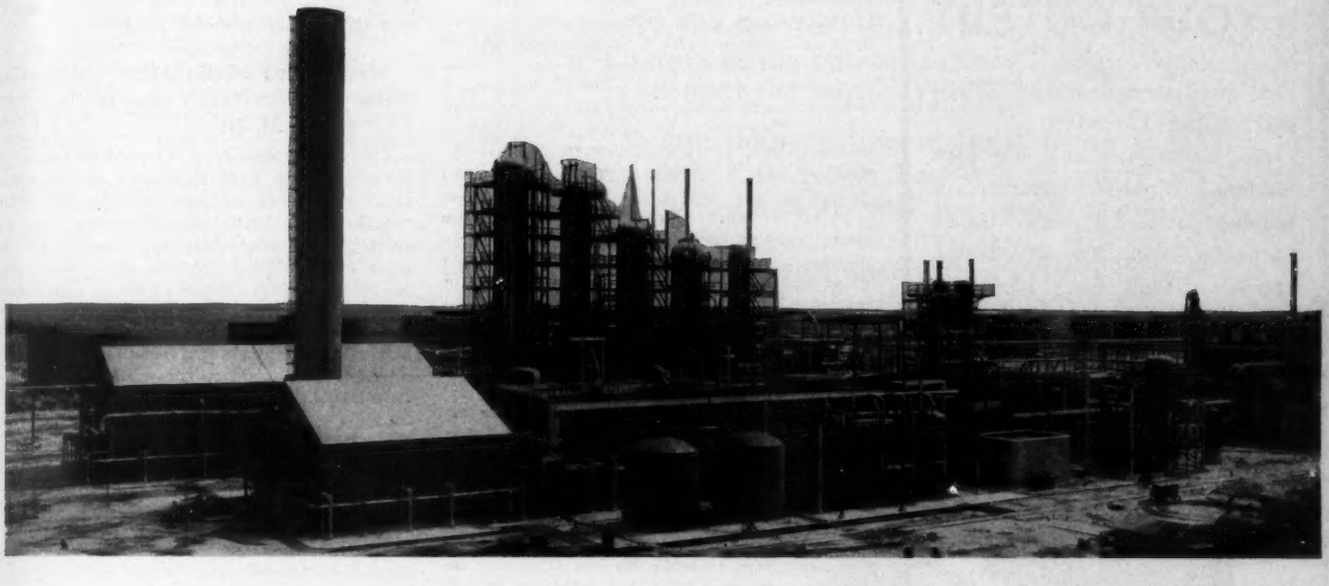

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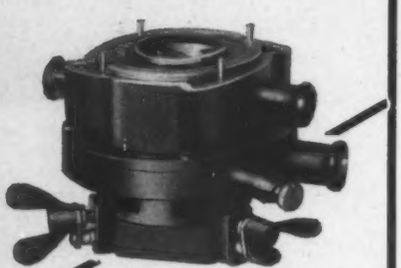

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through bare and insulated furnace walls. Furnace crowns and roofs have not ordinarily been insulated because it was believed that the more frequent renewal of brick work and the loss occasioned by shut-downs would more than offset the gain in fuel enconomy. The author is of the opinion that this is not true and that high temperature furnaces can and should be insulated. Charts are given for determining heat loss through convection, for the emissivity of paints and refractories, and for the thermal conductance of various insulating materials.

Reversal of Emulsion Type. C. L. WILSON. *Jour. Chem. Soc* (1934), 1360-1361.

Pure oil and water ordinarily give the same type of emulsion with a simple emulsifier no matter what the proportion of the two phases. In order to reverse the type of emulsion, a substance that will produce the opposite emulsifying effect must be added. When sodium oleate is used as an emulsifier, the salt is hydrolised and is therefore present as sodium hydroxide, oleic acid and sodium oleate rather than as the simple sodium salt. Using a large excess of oleic acid along with sodium oleate results in an emulsion of the water-in-oil type upon homogenization, when the benzene is in excess of 62%. The type of emulsion was found to be affected more by variation in the sodium hydroxide than in the oleic acid. Gentle continuous shaking ordinarily gives water-in-oil emulsion, whereas vigorous intermittent shaking gives oil-in-water emulsion, but these are reversed upon homogenization if enough oleic acid is present. If benzene in added to water in 5 c.c. portions with shaking after each addition, the emulsion is of the oil-in-water. However, it is reversed upon homogenization. The author believes that an emulsifier has two separate functions: first, to lower the interfacial tension, and second, to stabilize the emulsion that is first formed.

Insulation of a Natural Inhibitor from Rumanian Cracked Distillate and Its Application to Selective Acid Refining. F. SAGER. *Jour. Inst. Pet. Tech.* **20** (1934), pp. 1044-50.

The results of the fixed time Voorhees and Eisinger gum test on a Dubbs gasoline from Rumanian crude are given. Results of the copper dish gum tests for the same gasoline samples are given. The effect of the soda and doctor treatment on the sulfuric acid treated Dubbs pressure distillate is described. A natural inhibitor was isolated from raw Rumanian Dubbs pressure distillate and the effect of this inhibitor on selectively treated gasoline was studied.

Refining, Testing and Utilization of Petroleum Oils. Pt. VI. Kerosene Treating. G. N. CRITCHLEY. *Fuel,* **13** (1934), 314-318.

The burning properties of kerosene are affected by asphaltic substances, highly unsaturated hydrocarbons, sulphur compounds and nitrogen compounds. According to Gurwitsch, 0.1% of soft asphalt will reduce the illuminating power of kerosene 41% at the end of three hours, and 60% at the end of four hours burning. According to Waterman, 1% of sulphur increases the soot forming property of kerosene 10 times, and 1% of halogen compounds 7 times. Up to 40% aromatic compounds increase the illuminating power of kerosene. The color reversion of kerosene is of several types: (1) A clear lemon yellow coloration that develops even in the dark and within a fairly short time. This can be completely removed by sunlight bleaching. It is caused by the oxidation of compounds such as phenols and cyclopentadienes, and possibly unsaturated napthenic acids. (2) A similar coloration caused by the presence of amino acids. This is not observed with acid treated kerosene. (3) Darkening caused by the presence of unsaturated compounds. (4) Brownish discoloration that develops slowly upon aging, exposure to light, and contact with various materials.

Treatment of kerosene with liquid sulphur dioxide greatly improves the burning qualities and removes sulphur and nitrogen compounds selectively. The Edeleanu process of treatment with liquid sulphur dioxide is described. Also sulphuric acid treatments are discussed. Fuming sulphuric acid is recommended for asphaltic kerosene, but acid of lesser strength is satisfactory for paraffin-base kerosene.

New Ways of Refining Lubricating Oils. R. FUSSTEIG. *Erdol u. Teer.* **10**, (1934), No. 33, 415-18.

The author discussed the acid treatment of lubricating oils. Lead linings for agitators that contain antimony and bismuth are less resistent than pure lead, but adding copper or tin raises the resistance. More refining work can be done with 3% of 93-94% acid than with 5% of 90% acid. The acid should be free of nitrogen oxide and arsenic, since these form nitro and arsenic compounds that cause a yellow coloration of the oil. Temperature increase increases the oxidizing action of the acid. On long standing, the soluble oxidation products form harmful polymerization products. However, if the oil is treated cold, sulfuric acid reacts slowly and the acid tar separates so slowly that losses are high. The acid should preferably be used in three portions: First, to dry the oil and to remove the substances most easily affected. Mechanical agitation is better than blowing with air. If the oil is free of water, the "pepper" collects in a ball. If traces of water are still present, the movement of the black smudge particles is not seen, and additional acid must be added until the oil is dry. The test can be made on a glass plate. An excess of acid reduces the lubricating value of the oil. Too little acid results in an oil of raw smell and dark color. The author gives a table showing the quantity of acid that should be used for different oils. The time of mixing oil and acid is important. If the mixing is insufficient, the acid tar does not collect and the losses in settling are large. If mixing is too long, the tar cokes and various of the reaction products redissolve in the oil. Various additions have been used to assist settling, such as oleic acid or strong caustic solution and sometimes water. Use of a centrifuge is desirable. Treatment with acid is followed by treatment with alkali, since the oil at this stage contains the original naphthenic acids, phenols, asphalts, sulphur compounds, sulphuric acid ethers, and sulphonic acids. The alkali treatment is complicated by emulsion formation and by hydrolysis of the soaps. The oil takes up some of the acid soaps. The problem of hydrolysis can be solved by the use of silicate earth. Usually it is advantageous to use earth in mixture, since the specific adsorptive action of earth varies from earth to earth, each being most effective in relation to some particular coloring type of coloring matter.

Water Tolerance of Mixtures of Gasoline with Ethyl Alcohol, Isopropyl Alcohol and Benzene. COLIN H. BAYLEY AND CLARENCE YARDLEY HOPKINS. *Canadian Jour. Research,* **11** (1934), pp. 505-19.

The critical solution temperature was determined for solutions of gasoline and isopropyl alcohol and gasoline, benzene and ethyl alcohol.

Two of the gasolines used were straight-run, commercial aviation fuels and the third was a liquid-phase cracked gasoline. The ethyl alcohol used contained 1.63 to 5.65 volume percent of water. The isopropyl alcohol used boiled at 82.4°C. at 760 mm. One sample contained 2.38% of water, the other 0.80% by volume. The benzene used was practically anhydrous. It was found that propyl alcohol was somewhat more effective than ethyl alcohol in lowering the critical solution temperature. At any given temperature, the critical water content increases rapidly with decrease in the percentage of gasoline. The use of cracked gasoline permitted higher water content than straight-run gasoline. Solutions containing gasoline and benzene, containing 30-40% of benzene, deposit crystals only slightly below 0°C. The addition of ethyl alcohol lowers the crystallizing temperature, and if sufficient alcohol is added, the cloud characteristic of the critical solution temperature may show before crystallization occurs. If a ternary solution contains 70% or more of cracked gasoline, crystallization does not occur in the temperature range 0 to —40°C. If the solution contains only 60% of gasoline and more than 15% of benzene, along with ethyl alcohol, crystals will separate at low temperatures. With a fixed percentage of benzene, the critical water content is rapidly raised by increasing the alcohol content. Isopropyl alcohol is much more effective in lowering the critical solution temperature than benzene. If half the ethyl alcohol in any given solution is replaced with isopropyl alcohol, the critical water content at —20°C. is increased 60%, and at —40°C. it is almost double.

How Good Is the Single-Trip Container? STEEL BARRELS AND DRUMS COMMITTEE, MANUFACTURING CHEMISTS ASSN. *Chem. & Met. Eng.* **41** (1934), pp. 648-9.

Interstate Commerce Commission regulations state that I. C. C. 5-E drums are single trip containers for flammable liquids flashing between 20 and 80°F. These drums are largely used in the alcohol and solvent industry. The tests of these drums, as specified by the I. C. C. regulations, are briefly described and discussed. When the specifications were drawn, it was felt that a container conforming to them was safe for transportation on the railroads provided the drum was not used again for flammable materials. In general this has proved to be the case. However, it is true that although practically all manufacturers sell drums at the same price so that there should be no apparent advantage in purchasing from one supplier as against another, it has been found that the drums made by some manufacturers are far better than the drums made by others. Hence the Manufacturing Chemists Association has conducted tests on the drums as made by ten manufacturers. These tests are described and the results are given. The tests indicate a considerable difference in the quality of the drums as made by different manufacturers.

Products: Properties and Utilization

Knocking of Motor Fuels and Its Prevention. IV. Alcohol. E. ENDO. *J. Fuel Soc., Japan,* **13** (1934), 79.

Studies were made on the use of alcohol as an anti-knock blending material. It was concluded that an amount of 15 to 20% of alcohol is most suitable for an aviation gasoline blend. Ethyl ether is a valuable stabilizer of these blends. The alcohol used should be over 98% alcohol. A 15% alcohol blend is equivalent to a 30% benzol blend in anti-knock value. The alcohol blend vaporizes satisfactorily and does not vapor lock. The fuel consumption and

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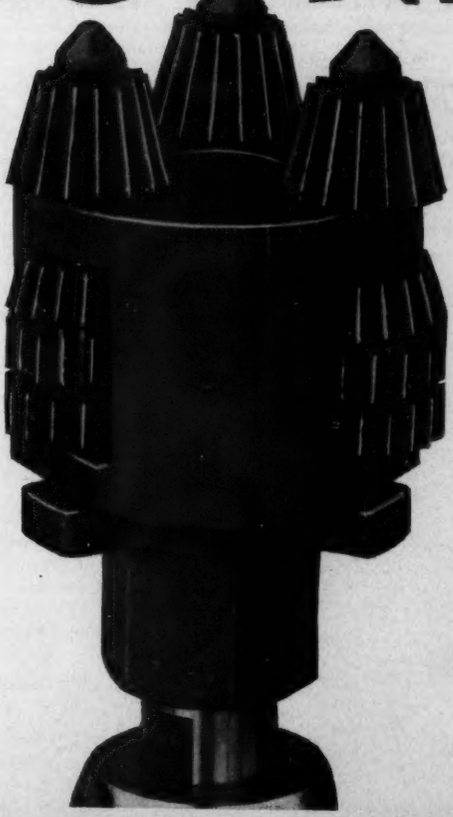

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power output of the alcohol blend are nearly the same as those of corresponding benzol or ethyl fluid blends.

Lubricants for Marine Steam Prime Movers. A. WOLF. *Mar. Eng.*, **46** (1934), 197-209.

Information is given on the types of lubricants used in the steam-driven units of vessels. The reasons for the use of oils of the various types are discussed. Oils of good emulsion properties are used in the circulating lubricating system of engines. "Blown" vegetable and animal oils compounded into minerals oils are frequently used for the external parts of marine steam engines of the open crank-case type.

Beneficial Use of Tin Compounds in Lubricants. E. W. J. MARDLES. *Tech. Publ. Internat. Tin Res. and Dev. Counc.*, Aug. 1934, C, No. 2.

The deterioration of lubricating oils through sludge formation caused by oxidation is inhibited by tin oleate, tetraphenyl tin, and some other compounds of tin. Compounds of gold, mercury chromium, cerium, bismuth and antimony have little effect on sludge formation. Compounds of copper, iron, silver, vanadium and manganese accelerate the rate of sludge formation.

Synthetic Lubricating Oils from Condensation Products of Ethylene. H. SCHILDWACHTER. *Angew. Chem.*, **47** (1934), 677-681.

The making of lubrication oils by the condensation of naphthalene, tetraline or coal-tar oils of 200-300°C. boiling point, by treatment with gaseous ethylene under 60 atmospheres pressure and in the presence of 5% anhydrous aluminum chloride, is described. The oils produced are similar to motor oils. They have a low pour point and a high viscosity for moderate molecular weight. The oils do not oxidize readily and are stable at high temperatures. They are originally free from asphalt and do not readily form new asphaltic matter. When subjected to the action of a silent electric discharge, the viscosity increases.

The Use of the Redwood No. 1 Viscometer for the Determination of Viscosity in Absolute Units. E. A. GOODE AND T. V. HEATH. *Jour. Inst. Pet. Tech.* **20** (1934), pp. 1054-6.

Discrepancies have been observed between absolute viscosities as derived from Redwood times of flow and those obtained by the U-tube viscometer according to British standard specifications 188-1929. Accordingly, it appeared desirable to check the values of the constants in the conversion equation for use in conjunction with the Redwood viscometer. Viscosities of various standard solutions were determined and an equation derived from the data so obtained that permits calculation of values of kinematic viscosity in close agreement with results as determined by the absolute Ostwald viscosimeter.

Wax in Petroleum Asphalts. J. MULLER AND ST. V. PILAT. *Asphalt u. Teer*, **34** (1934), 649-654.

Shell-still produced asphalt has a lower ductility than pipe-still products of similar ring and ball softening point. Was probably has a small effect on ductility compared to the effect of the high molecular weight, large size asphaltic molecules that are formed during the long heating at high temperature in the shell-still process of making asphalt. These high molecular weight substances are not true asphaltenes, as is indicated by the fact that they are only partially soluble in carbon tetrachloride. Data are given on the solubilities in various solvents. Ductility increases with specific gravity up to a maximum, and then drops. The influence of the high molecular weight asphaltic bodies was shown by mixing them after purification, drying and pulverization, into a waxy asphalt. The more finely the benzine insoluble asphaltenes, the higher the softening point of the mixture. On account of the fact that the asphaltenes are fairly soluble in aromatic hydrocarbons, the effect of adding naphthalene to mixures was studied. The ductility of the asphalt improved up to a naphthalene content of 7.5%, after which it decreased. The effect of naphthalene is still observed at a temperature of 0°C. where it would be expected that the naphthalene would have crystallized.

Determination of Sulphur in Oils. E. GRAEFE. *Petroleum*, **30** (1934), No. 38, 2-3.

Sulphonic acids are not formed when hydrocarbons containing sulphur are burned in a bomb, although these acids may be formed by oxidation of hydrocarbons at normal temperatures in the presence of water and in the light. Loss of sulphur dioxide or sulphur trioxide from a bomb, which is a frequent source of errors, can be effectively prevented by using an alkaline oxidizing solution, for example, aqueous sodium peroxide in place of the usual distilled water as the absorption medium in the bomb. If a bomb is not available, combustion can frequently be successfully effected in a glass flask at ordinary pressure.

Fundamental Physical Data

Rate of Solution of Methane in Quiescent Liquid Hydrocarbons. II. E. S. HILL AND W. N. LACEY. *Ind. Eng. Chem.* **26** (1934), pp. 1324-7.

In connection with repressuring operations for recovering oil and for the storage of gas, there has been need for information on the rate at which the gas dissolves in the oil in the formation and on the quantity of gas that will dissolve. The principal component of most natural gases is methane, and this has therefore been first investigated. The rates of solution of methane in seventeen oils were measured at 86°F. and in four oils at 113° to 140°F. The data are presented in tabular and graphical form.

Rate of Solution of Propane in Quiescent Liquid Hydrocarbons. E. S. HILL AND W. N. LACEY. *Ind. Eng. Chem.* **26** (1934), pp. 1327-31.

The paper is a report on the rate of solution of the second most important component of gases. Although present in smaller amounts in natural gas than methane, its solubility in petroleum oils is much greater under the same conditions. Measurements were made of the rate of solution of propane in kerosene and in spray oil at pressures up to nearly 67% of the vapor pressure of liquid propane at the temperature of the determinations, namely 86°F., 113°F., and 140F°. The volume increase was determined, as well as the final amount of gas dissolved in the oil at equilibrium. The authors state that it is easy to see that the physical advantages of using a natural gas rich in the hydrocarbons of higher molecular weight than methane are great. Greater solubility at similar pressures results in correspondingly greater changes in the viscosities of the oils, such as reduction of the specific gravity and viscosity. The rate at which propane dissolves is much greater than it is for methane at the same pressure, so that much lower pressures can be used to accomplish the same results with a very wet gas than are necessary with a dry gas for repressuring.

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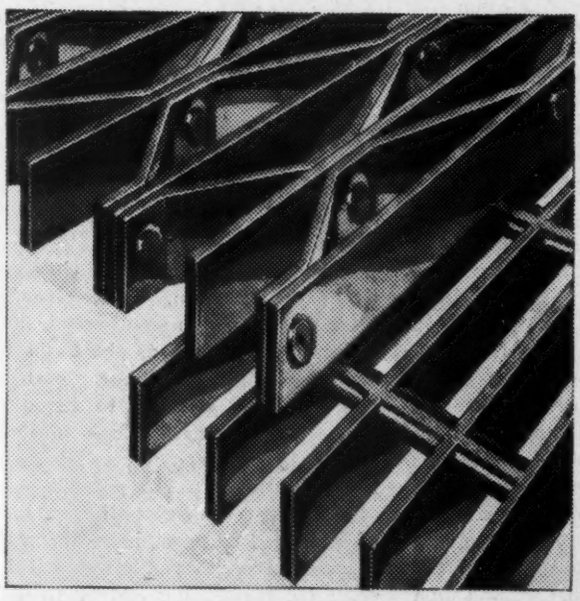

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Electric Control

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has developed oil-immersed linestarters (Class 11-202) for use in locations where either corrosive or explosive gases are present. The contactor is submerged under an adequate head of oil for both corrosion protection and quenching the arc but the core and tank are heavy cast iron alloy of sufficient strength to withstand an internal explosion, should there be an inadequate quantity of oil.

The class 11-200 air brake type of linestarter is available in several types of enclosures. Sheet steel, dust tight enclosures are available for locations where the air is not contaminated with acid or explosive vapors. Explosion-proof cast iron housings are for use in corrosive and explosive atmospheres, either indoors or exposed to the weather.

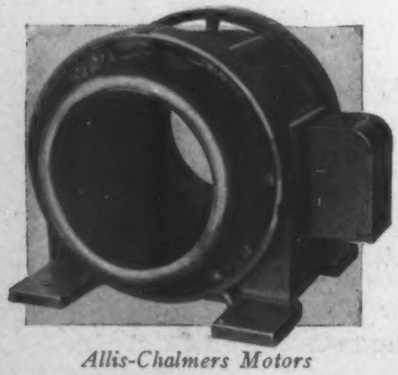
Combination linestarters, with indoor circuit protection and disconnect features, are available in two general classes. Class 11-204 includes a manually operated quick break disconnect switch, fused or unfused, with the standard starter, in sheet steel or in cast iron housings.

Class 11-206 includes a type AB De-ion circuit breaker with the standard starter, in sheet steel or in cast iron enclosures. These combination units are factory assembled and wired, requiring only the mounting of a single unit and installation of incoming and outgoing leads to be placed in service.

Seal Clad Motors

ALLIS-CHALMERS MANUFACTURING COMPANY

Allis-Chalmers Manufacturing Company, Milwaukee, has introduced new "Seal Clad" squirrel cage motors, which are of open type construction with permanent coil protection. Hard, smooth Bakelite shields are sealed over the stator coils giving protection against metallic dust, grit, oil, moisture, mild acids and other agents injurious to insulation. The motors are built in ratings up to 25-horsepower, 1800 r.p.m. and suited to broad type of application. The motors have cast-steel frames, twistless and distortionless stators; silver braised, indestructible rotors; oil and dust-tight sleeve or anti-friction bearings.



Allis-Chalmers Motors

Centrifugal Pumps

DEMING COMPANY

Deming Company, Salem, Ohio, recently placed on the market a new line of close coupled side suction centrifugal pumping units. The outstanding feature of the new line resides in the fact that any make of standard ball bearing motor of the open, enclosed, splash-proof or explosion-proof type can be used. Due to the unique connection of motor and pump shafts the necessity of special motor end bells and shafts is eliminated. Pump and motor are mounted on a substantial base plate, eliminating any unbalanced overhang of pump or motor. The cradle mounting of the pump permits expansion when handling hot liquids without disturbing the alignment of the unit, it is claimed by the manufacturer.

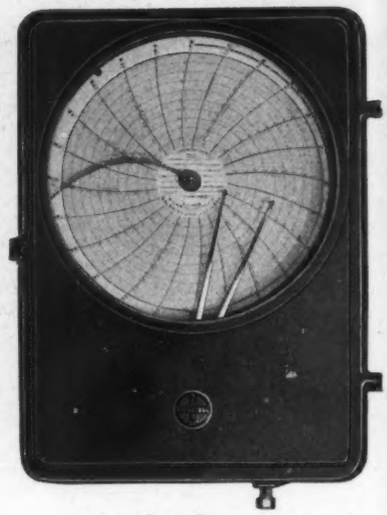
Control Instruments

AMERICAN METER COMPANY

American Meter Company, 60 East 42nd Street, New York, announces an important advance in appearance, utility and convenience of orifice measurement and flow control instruments in the development of its new Type W case. The improved case is now standard for this company's line of recording and integrating flow and orifice meters, rate-volume controllers, liquid level indicators and controllers. Simple lines and velvet black finish are in keeping with the highest standards for both instrument and panel board design.

The case body and door are cast of an aluminum alloy with special attention to the construction of door hinges and hinge pins, which are produced from special alloys to minimize the possibility of corrosion. A sponge rubber gasket secured in a recess of the door makes the case moisture and dust proof.

Both time and labor are saved in the necessary inspection of the instrument by making the chart dial size such that the pressure spring, stuffing box and other working parts are visible when the door is open. The new case is made highly satisfactory for flush mounting. For that type of installation a flange is cast integral with the case, the door being hinged to the flange.



American Instrument

For the flow control instruments, the Type W case has the air supply gage, and the gage indicating the pressure on the diaphragm head of the control valve, mounted on brackets secured to the inside of the case. The door is provided with two additional round windows, making these gage indications visible at all times. The construction here also facilitates flush mounting since all air connections are behind the panel board and are made into flanges secured to the sides or back of the case.

Compressor

PENNSYLVANIA PUMP AND COMPRESSOR COMPANY

Pennsylvania Pump & Compressor Company, Easton, Pennsylvania, is manufacturing a new type air or gas compressor, known as the Class 3-AT. It is the single-stage, horizontal, roller bearing type, adapted to heavy duty service, and is available is sizes from five to 125 horsepower, and from pressures from 12 to 150 pounds.

The new compressor has a number of improved features, including a frame of great strength and symmetrical proportions, connecting rod of steel forging with solid eye at each end, steel forging crank shaft with ends tapered to fit the taper bore of the wheel hubs, box type crosshead, box type piston with a single casting cored hollow and strongly ribbed, and necessary roller bearings.

Welder

LINCOLN ELECTRIC COMPANY

The Lincoln Electric Company, Cleveland, Ohio, announces a new alternating current welder known as the Lincoln "Shield Arc AC." This new welder is of the motor generator type which takes two-phase or three-phase alternating current of standard voltages and frequencies and converts it into alternating current of lower voltage and at that higher frequency most suitable for arc welding with either heavily coated or washed electrodes in all positions.

For this equipment, the manufacturer claims the following advantages: Improved arc characteristics due to the higher frequency such as more stable arc, less magnetic blow, easier starting of arc; improved weld metal since there is less spatter loss and in multiple pass welding greater density; better power characteristics from the line. Since the machine takes power from all phases instead of from one phase, unbalancing of phases is eliminated and a power factor of approximately double that of the transformer type is obtained.

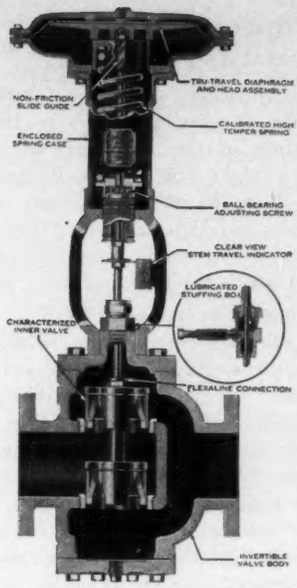
Since this type of welder draws from the line balanced power at lower amperage and higher power factor, the regulation of the transmission equipment is materially improved.

The new "Shield Arc AC" welder is built in portable and stationary AC motor driven models in two sizes. The smaller capacity machine can be used for continuous welding with electrodes of 3/32-inch to 5/16-inch in size; the larger capacity welder handles electrodes from one eighth-inch to three eighths-inch in size. These machines are wired for 220, 440 or 550 volts, AC supply, two- or three-phase, 50 and 60 cycles.

Diaphragm Control Valve

THE FISHER GOVERNOR COMPANY

The Fisher Governor Company recently introduced a new designed diaphragm control valve for use in connection with pilot valves for either pressure control or liquid level control. The diaphragm control unit is known as Tru-Travel Control Valve and has several features of interest. Diaphragm control valves are one of the most important features of pilot or instrument actuated control systems. Every point of the new Type 57-T, has been engineered to accomplish a definite and necessary function. The inner valve being the heart of the control has received special attention because on this part depends the reaction of the flow through the regulator. This inner valve is known as the characterized inner valve, having specially designed V-port construction which gives a fine throt-



Fisher Control Valve

tling control over the first increment of lift, then proceeds to throttle or float in proper ratio to the travel until the maximum capacity is reached. The inner valve is connected to the valve stem by a patented flexaline stem connection, allowing true alignment of the inner valve in the ports without binding. The diaphragm and spring topwork has its definite and distinct feature. A specially shaped diaphragm head, which uniform effective area has been utilized as well as non-friction slide guides and a precision calibrated spring contribute to give a definite travel, or movement of the inner valve and diaphragm combination for a definite pressure applied to the diaphragm.

Boiler Meter

BAILEY METER COMPANY

Bailey Meter Company, Cleveland, Ohio, has developed a new steam flow air flow boiler meter particularly well suited to industrial service.

This meter records steam flow from the boiler, air flow supplied for combustion and flue gas temperature—all on one 12-inch diameter uniformly graduated chart. It also indicates steam flow on a porcelain enameled scale and integrates the total steam flow on a six-digit counter.

The three important factors of boiler operation—combustion efficiency, steam output, and flue gas temperature—are combined and coordinated in this one meter. It is equipped with the new direct-reading Bailey escapement type integrator; an accurate, sensitive air flow mechanism; a sturdy, dust and moisture-proof pressed steel casing suitable for flush front or surface mounting; and a simplified, powerful steam flow mechanism with interchangeable head chambers.

The air flow mechanism provides for easy, quick and accurate adjustment to prevailing combustion conditions.

Simplicity, accuracy and flexibility are combined in the new steam flow mechanism by using a powerful Bailey Ledoux bell in conjunction with interchangeable mercury reservoirs. This construction eliminates the necessity of opening steam lines to replace orifices or flow nozzles when changes in meter capacity are desired.

The record of flue gas temperature which is given by this meter is a dependable check on the condition of the boiler baffles and on the efficiency of the heat transfer through the boiler tubes.

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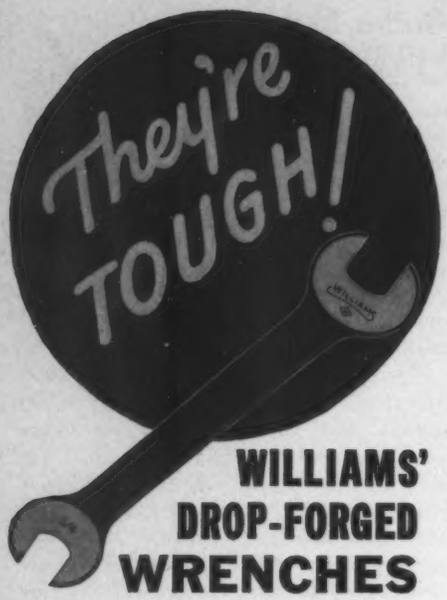

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Superior tools in every sense of the word, Williams' Drop-Forged Wrenches are extremely rugged. Jaws are hard and tough with accurately milled openings. 50 patterns; over 1000 sizes. Most complete line of drop-forged wrenches in the world—meet every oil field requirement.

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Hydropress Pump

BYRON JACKSON COMPANY

Byron Jackson Company, Berkeley, California, is offering the new Hydropress pump in the following sizes and capacities, eight-inch, 10 to 35 gallons; 10-inch, 30 to 65 gallons; 12-inch, 60 to 110 gallons and 15-inch, 90 to 200 gallons. The size connotes the diameters of the barrel in which the inner volute is placed.

The pump, in essence, consists of a centrifugal multi-stage volute, split along the center line, placed within an enclosing barrel, with the barrel cover carrying the suction and discharge nozzles. The inner volute is cast in two halves, held together on a ground face without a gasket by the pressure which the pump produces. The pumped liquid is discharged from the inner volute into the outer barrel, and the liquid then acts as a compression medium to hold the two halves of the inner volute together, equalizing the pressure inside and outside of the inner volute. The outer barrel is of electric welded steel, or of forged steel for very high pressures, and is the part of the pump which carries the full discharge pressure. This barrel is a single piece (not split), with one blind end, and designed with a circular cover closing the one open end, so that there is but one circular metallic joint in the pump assembly proper exposed to the pressures developed by the unit. There is only one stuffing box, so located that it is under suction pressure where the pump shaft extends vertically through the barrel cover to the motor.

They can be used for water, oils or other liquids in process work, where the requirements are for high pressure and low capacity. For handling hot liquids up to 900° F., the pumps are supplied with special alloy materials.

Cleaning Unit

HOMESTEAD VALVE MANUFACTURING COMPANY

Homestead Valve Manufacturing Company, Coraopolis, Pa., has developed the Fireless Hypressure jenny, an addition to its line of vapor spray cleaning units. The design of this new model is marked by simplicity, compactness and the fewest possible parts. It is portable and easy to move, being only 20 inches wide, 45 inches high, and 52 inches long, including the handle. It uses plant steam, instead of producing its vapor by means of an oil-fired generator.

The unit consists of a water or solution tank, containing an automatic float level valve and a rotary pump, directly connected to and driven by a fractional horsepower motor, operated from a light socket. The amount of compound and moisture content can be varied at will by means of a manually adjustable mechanism, which enables the operator to obtain anything from a heavy cutting spray to a light cleaning mist.

Operating over a range of pressure from 50 to 250 pounds, the Fireless Hypressure jenny is designed to meet a demand for vapor spray cleaning in refineries chemical plants, garages and other establishments where plant steam is available. The vapor spray method of cleaning has proven to be a time and labor saver in the cleaning of machinery of all kinds, motors, skylights, exterior and interior walls, paint cleaning and stripping, or wherever cleaning is a problem.

Turbo Blowers

ALLIS-CHALMERS MANUFACTURING COMPANY

Allis-Chalmers Manufacturing Company, Milwaukee, is introducing a new compact centrifugal compressor (turbo-blower) which makes use of a gearmotor. By using the gearmotor for speed increase the blower can run at

Allis-Chalmers Blower

higher than motor speeds, it is said, thus reducing dimensions and improving performance. Pressures from .75 pound G. to 3.0 pounds G. are developed, the volumetric capacities corresponding to motor outputs from 3 to 30 horsepower. The units have application for foundry cupola blowing, oil and gas fired furnaces, pneumatic conveying, agitation and aeration, and for similar moderately low pressure air or gas supply services.

Compressed Air Filter

STAYNEW FILTER CORPORATION

Staynew Filter Corporation, Rochester, N. Y., has developed model CP for compressed air and vacuum lines, as a means of providing a positive, high efficiency filter in addition to the inertia or centrifugal principle of separation.

Removal of water, oil, iron rust, pipe scale and any other foreign matter is accomplished. The filtering medium may be cleaned quickly by reversing the flow of the air. By closing a valve to shut off air going into the filter housing and

opening the drain cock the air in the outlet pipes or hose is blown back through the filter proper, removing material collected on the filtering surface.

These filters will deliver clean dry air for paint spraying, compressed air tools, hoists, cleaning operations, agitating liquids, ice making, chemical processes, etc., when installed near the point where the air is being used. It is obtainable for eight sizes of pipe ranging from quarter-inch to three inches. The use of two or more units in parallel is recommended for larger pipe sizes and capacities.

These filters remove all water, oil, rust, iron scales or other foreign matter from air passing through pipes, and prevent wear on all tools or other equipment operated by compressed air.

The model CP filter has an aluminum housing enclosed in a pressed steel container with flanged joint made to withstand a working pressure of 125 pounds. Higher pressure shells can be supplied as special equipment.

Metameter

THE BRISTOL COMPANY

The Bristol Company, Waterbury, Connecticut, announces the latest development in telemetering; the metameter, which makes it possible to control temperatures, pressures, levels, and other process conditions or operations at any distant place a few feet or several thousand miles away, according to the manufacturers.

It consists of a transmitter at the location where the temperature or pressure is being measured, an electrical circuit for conveying the impulses automatically sent out by this transmitter, and a receiving instrument at headquarters for mechanically translating the impulses received into the measurements made. The 12-inch chart keeps a continuous record of every fluctuation at the distant point. Any change from normal, whether abrupt and large or minute and gradual, is immediately and permanently recorded.

The durations and not the intensities of the transmitted impulses are proportional to the values measured. Only a simple two-wire circuit is needed. Where available any existing telephone line may be employed without danger of interference with, or from, conversation carried, line inductance or capacity.

In addition to the large chart, the metameter has been perfected so that any kind and frequency of line current may be used. Both line current and voltage are small. They are free from interference by changes in voltage or other line conditions. There are no exposed contacts. Power consumption is small. Synchronous power sources are unnecessary. Bristol measuring elements are used. The equipment is self-checking and self-restoring, and is applicable to remote control.

Valves

THE FAIRBANKS COMPANY

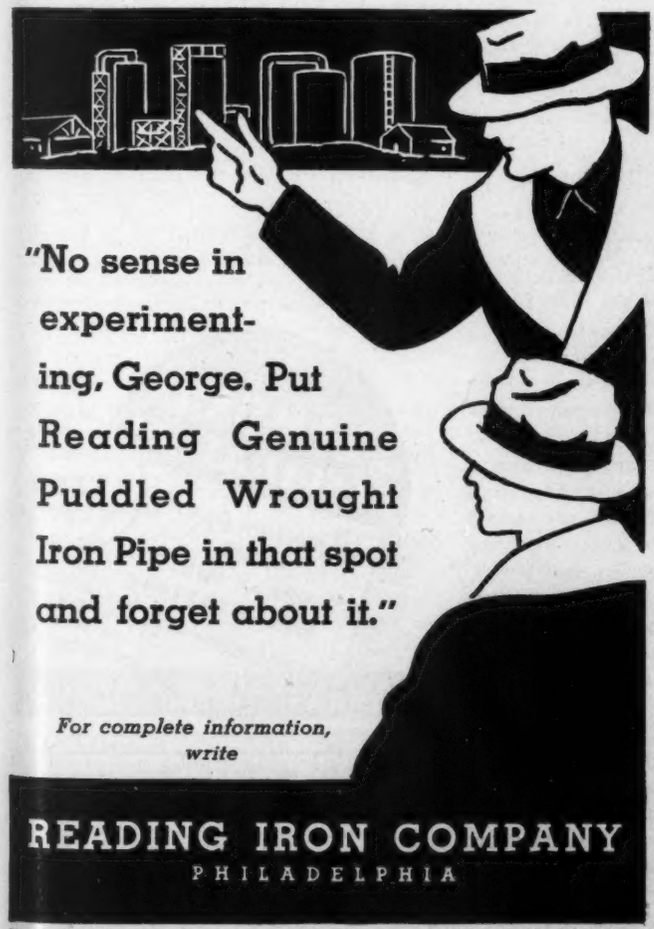
The Fairbanks Company, 393 Lafayette St., New York, announces a new line of renewable bronze, angle and globe valves. Some of the outstanding features the manufacturers claim for these valves are: The radial seat, between body and bonnet, insures a tight joint and perfect alignment of all parts, which decreases wear. This seat is drawn to a tight joint by the union nut without sliding or scraping the surface of seat, which increases the life of valve and assures a tight body-joint after every assembly.

The disc ring not only serves efficiently in the control of the steam but also on hot and cold water. It is composed of long-fibre asbestos, compounded with vulcanizing elements and given a special cure to produce a most efficient disc ring.

The disc holder is of standard dimensions, permitting the use of other standard makes of disc rings if desired.

The stem is of rolled rod bronze, averaging 65,000 pounds tensile strength. At least five clean cut Acme threads are at all times in contact with the bonnet.

The union nut is heavy bronze with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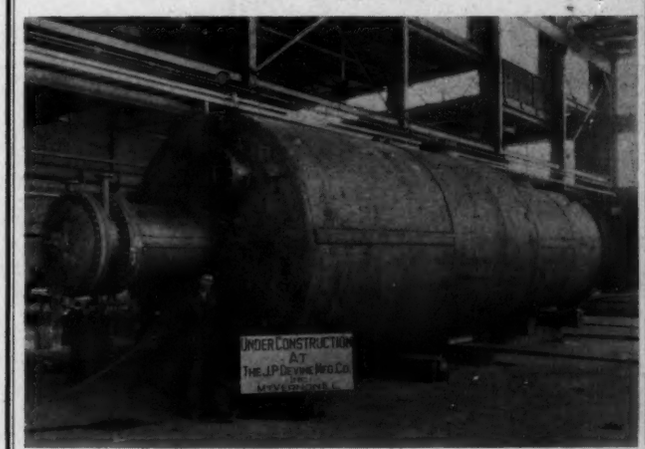

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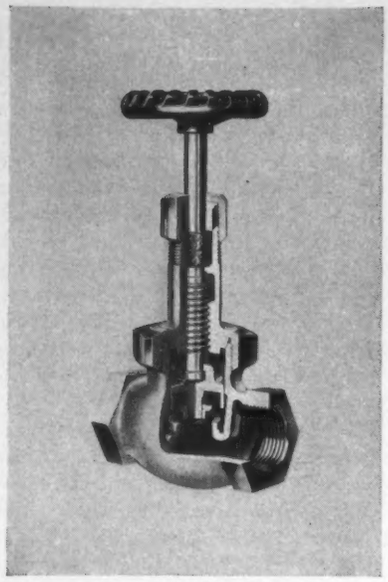

Fairbanks Valve

large hexes for a firm wrench grip and permits removal of bonnet with less risk of damage.

The protected top seat above the threads on stem gives greater assurance of a clean, tight joint when the valve is fully opened for the purpose of repacking the valve under pressure.

The ventilated, malleable iron handwheel assures a firm, cool grip. The bronze nut holding the wheel is well below the wheel rim surface thus protecting the hand. This nut is securely held with a lock washer.

All parts of globe and angle valves are interchangeable.

Hermetically Sealed Capacitors

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania, announces a new line of hermetically sealed power capacitors about ½ the size and 1/3 the weight of conventional oil field units.

The individual units are impregnated with the new Westinghouse fire-proof impregnating medium inerteen, are housed in welded cases of .05 sheet steel, and equipped with rugged solder seal porcelain terminal bushings. Because of their compact, lightweight, and leakproof design, these new capacitors expand the economical use of power factor correction in many industrial plants.

The compact individual units are assembled in newly designed welded racks, frames, or cabinets for any sort of mounting including pole mounting. Since the engineering design is based on standard component parts, practically any size capacitor is available from 5 kva at 230 volts up to 1200 kva at 6900 volts.

Pumps

WORTHINGTON PUMP AND MACH. CORPORATION

Worthington Pump and Machinery Corporation, Harrison, New Jersey, presents an improved line of piston pattern pumps designed particularly for the exacting requirements of the petroleum refiner.

The liquid ends are of the side pot type, with minimum clearance, and with removable cylinder liners. Features of importance are ease of accessibility and interchangeability of wearing parts. The liquid valves are located in pots on the sides of the cylinder arranged to give steam line flow from suction to discharge. Each valve is accessible independently of the other.

The liquid cylinders are compact, and rugged in design, for discharge working pressures up to 500 p.s.i. in Wompco metal and 700 p.s.i. in cast steel. Chrome alloy valve service and liquid end piston rods, and Ni-Resist cylinder liners are standard fittings. The cast iron pistons may be fitted with either hammered iron or fibrous packing rings as service conditions require. For pumping oils or distillates at temperatures above their flash points, the side pot pumps are fitted with extra deep water-jacketed stuffing boxes. The valve service, cylinder liners, liquid pistons and packing are interchangeable between simplex and duplex pumps of the same bore and stroke.

The Worthington piston pattern side pot pumps are available as simplex and duplex steam driven, or as duplex power driven by Worthington steam, gas or Diesel engines or by electric motors, either direct connected or through Worthington Multi-V-Drive.

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CATALOGS . . . BULLETINS

Helpful Publications Which Manufacturers Will Be Glad to Send Free for the Asking

Hose

American Metal Hose Company, Waterbury, Conn., has issued a four-page bulletin describing construction and application of four different styles of metal hose, including interlocking and square locked types.

Hose

Electric Hose & Rubber Company, Wilmington, Del., has issued "Industrial Hose Handbook" which is a 72-page book of original data and experiences in hose installation and maintenance and is replete with an index of the kinds of hose suitable for various industries.

Electrical Equipment

Crocker-Wheeler Electric Manufacturing Company, Ampere, N. J., is distributing a 16-page bulletin describing the use of synchronous motors for driving equipment not requiring variable or adjustable speed.

Filtration

Filtration Engineers, Inc., Summer Avenue and Erie R. R., Newark, N. J., has issued a new bulletin descriptive of continuous vacuum filters for process work.

Metals and Alloys

Crucible Steel Company of America, 405 Lexington Avenue, New York, is distributing Section 3, General Catalog, consisting of 80 pages dealing with properties and uses on corrosion and heat resisting steels made by this company.

Metals and Alloys

Michiana Products Company, Alloy Division, Michigan City, Indiana, has issued a new bulletin on corrosion and heat resisting alloy castings.

Refractories

McLeod & Henry Company, Troy, N. Y., is distributing its 1935 catalog on the design, installation and service advantages of its furnace linings and arches for boiler furnaces.

Water Treatment

Cochrane Corporation, 17th Street, Philadelphia, has issued bulletin 700, consisting of 24 pages on deaerating heaters; Bulletin 689, 48 pages on fundamentals of and recent developments in the conditioning of boiler feed water by the hot and cold processes and zeolite softeners.

Welding

Lincoln Electric Company, Cleveland, Ohio, has issued welder specification bulletins 303, 304 and 305, giving specifications on three belt-driven and two engine-driven welders.

Rubber Goods

The B. F. Goodrich Company, Mechanical Division, Akron, Ohio, is distributing a new book of engineering data designed to simplify the selection of belting, hose, and other mechanical rubber goods for industrial service. In the 21 pages over 200 items are described. More than 100 diagrams and photographs are included as are glossaries, tables and technical data of general interest.

Tube Cleaners

The Airtool Manufacturing Company of Springfield, Ohio, has issued two new bulletins descriptive of its complete line of tube cleaners. Bulletin No. 10 pertains to the company's complete line of tube cleaners for oil refineries and Bulletin No. 11 describes tube cleaners for boiler plants. Both are well illustrated and contain useful engineering data.

Flowmeter

American Meter Company, 60 East 42nd St., New York, has announced a new catalog and instruction bulletin on the Metric indicating flowmeter, designated as E-3 and is adapted for use with the company's loose-leaf binder recently introduced. The following additional bulletins were released in January—E G 40-Ironcase Meters; E-5 Rate-Volume and Liquid Level Controllers and E-12, Base Pressure and Base Volume Indexes.

DuPrene

The Rubber Chemicals Division, E. I. du Pont de Nemours & Company, Wilmington, Delaware, under the title "A Story of Man-Made Rubber," has released the first popular description of DuPrene in a small illustrated booklet. Of interest is the clear and understandable explanation of how DuPrene is synthesized from coal and limestone.

Pressure Vessels

The M. W. Kellogg Company, 225 Broadway, New York, is distributing a new bulletin "Kellogg Masterweld Refinery Equipment," describing some of the large pressure vessels manufactured by the company for use in petroleum refineries.

Boiler Feed Control

Norther Equipment Company, Erie, Pa., has published a valuable illustrated paper by E. G. Grady, plant engineer, on "Operating Experience at Masonite with High-Pressure Boiler Feed Control." The article is designated as Folder No. 137.

Seal

Durametallic Corporation, Kalamazoo, Mich., is distributing a pamphlet dealing with Dura Seal, a new mechanical seal for centrifugal and rotary pumps.

Can Filler

Sprague-Sells Corporation, Hoopeston, Illinois, is distributing a brochure "A Ripple That Became a Tidal Wave—The Story of Canned Oil," dealing with facts and figures relating to canning lubricating oils and can fillers.

Pyrometers

C. J. Tagliabue Manufacturing Company, Park and Nostrand Avenues, Brooklyn, New York, is distributing a new catalog "TAG Pyrometers, High Speed Photo-Electric Action," describing its non-hunting, non-drifting, proportional controller-record, which is photo-electrically balanced.

Indicator

Yarnall-Waring Company, Chestnut Hill, Philadelphia, has issued bulletin WG-1804, giving information on the Yarway Eye Line Indicator for use on boilers which provides for easy vision of the water level.

Floats

W. H. Nicholson & Company, 12 Oregon Street, Wilkes-Barre, Pennsylvania, has issued Bulletin 431, on Nicholson welded steel floats and stainless steel floats for steam traps, water columns, tanks, float valves, liquid level controls, etc. The floats are heat treated and non-collapsible and the bulletin includes description and engineering information.

Roofing

Johns-Manville, 22 East 40th Street, New York, is distributing a new booklet on 3 Modern Developments that give you the Ideal Roof. It deals with protection of buildings, roof repairs, roof insulation and reduction of heating costs. A new complete roofing unit is discussed.

Valves

The Fairbanks Company, New York, N. Y., has issued a new bulletin on its lines of renewable gate valves including renewable bronze ring gate valves, bronze gate valves, and iron body gate valves. The bulletin includes illustrations and directions.

Pumps

Byron Jackson Company, Department 58, Berkeley, Calif., is distributing a bulletin describing the company's new Hydropress pump, a pump which embodies proven principles of centrifugal pumps and permits building up of pressures to 2800 pounds. The number of stages ranges from 4 to 54 depending upon conditions, and capacities range from 10 to 250 gallons per minute.

Diesel Engine

Ingersoll-Rand, New York, has issued a catalog which describes the stationary type Diesel engine it manufactures. The catalog will be mailed to interested parties.

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